Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 16,319 square feet, more or less

Interest: Easement

Date: February 1, 1994

TRACT 110-02

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal so called, and known and numbered as 722 Broadway and further bounded and described as follows:

Beginning at an iron pin set at the northwesterly corner of the parcel; said pin being a point on the southerly line of Broadway; said point bearing N 82° 56' 05" E and being 16.85 feet distant from an angle in said line; thence along said southerly line of Broadway

N 82° 56' 05" E, a distance of 31.29 feet to a point at the back edge of the concrete wall of the Pawtucket Canal; thence running along the back edge of said wall as follows:

S 18° 33' 43" E, a distance of 103.20 feet to an iron pin set at an angle in the wall,

S 08° 06' 33" W, a distance of 65.99 feet to an iron pin set at an angle in the wall, and

S 05° 50' 20"E, a distance of 192.18 feet to an iron pin set at an angle in the wall; thence continuing along the back edge of the concrete and then granite wall of the Pawtucket canal as follows:

S 15° 12' 18" E, a distance of 231.72 feet to an x-cut set at an angle in the wall, and

S 31° 44' 31" E, a distance of 17.94 feet to a point on the northerly line of location of the Boston and Maine Railroad; thence running along said railroad location line as follows:

N 84° 50' 16" W, a distance of 14.34 feet to a drill hole set at an angle in said location line, and

S 82° 00' 51" W, a distance of 16.74 feet to an iron pin set at the easterly line of land now or formerly of the City of Lowell; thence running along said land of the City of Lowell

N 15° 14' 25" W, a distance of 264.45 feet to an iron pin found at the southerly corner of land now or formerly of the Commonwealth of Massachusetts; thence running along said land of the Commonwealth of Massachusetts by three courses as follows:

N 05° 40' 50" W, a distance of 178.07 feet to an iron pin found,

N 08° 20' 10" E, a distance of 72.30 feet to an iron pin set, and

N 18° 27' 01" E, a distance of 91.21 feet to the point of beginning.

Containing 16,319 square feet of land, more or less.

Being shown as Parcel 7A on sheet 5 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 57,348 square feet, more or less

Interest: Easement

Date: February 1, 1994

TRACT 110-03

Two certain parcels of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal so called, and known and numbered as 713 Broadway and further bounded and described as follows:

PARCEL I:

Beginning at a stone bound found at the southwesterly corner of the parcel, said point being located at an angle on the northerly line of Broadway; thence

N 21° 35' 30" W, by land now or formerly of the Commonwealth of Massachusetts, 190.48 feet to a concrete bound found; thence

N 21° 35' 30" W, by land now or formerly of Endevor Incorporated 269.52 feet to a point; thence by land now or formerly of the Proprietors of Locks and Canals by five courses as follows:

S 40° 51' 32" E, a distance of 63.10 feet to a point,

S 30° 21' 02" E, a distance of 98.70 feet to a point,

S 28° 42' 32" E, a distance of 180.03 feet to a point,

S 27° 06' 12" E, a distance of 88.85 feet to a point, and

S 03° 54' 52" E, a distance of 51.47 feet to a point on the northerly line of Broadway; thence

S 82° 56' 05" W, by said northerly line of Broadway 52.74 feet to the point of beginning.

Containing 19,848 square feet of land, more or less.

Being shown as Parcel 8A, Lot 1 on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park; Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 24 May 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

PARCEL II:

Beginning at a point at the southwesterly corner of the parcel on the northerly line of Broadway, said point being N 82° 56' 05" E, a distance of 52.74 feet of a stone bound found on the northerly line of Broadway; thence by land now or formerly of the Proprietors of Locks and Canals by five courses as follows:

N 03° 54' 52" W, a distance of 51.47 feet to a point,

N 27° 06' 12" W, a distance of 88.85 feet to a point,

N 28° 42' 32" W, a distance of180.03 feet to a point,

N 30° 21' 02" W, a distance of 98.70 feet to a point, and

N 40° 51' 32" W, a distance of 63.10 feet to a point, thence by land now or formerly of the Commonwealth of Massachusetts by four courses as follows:

N 39° 26' 01" W, a distance of 11.26 feet to a point,

N 41° 26' 13" W, a distance of 65.21 feet to a point,

N 40° 55' 22" W, a distance of 28.28 feet to a point, and

N 38° 57' 44" W, a distance of 6.35 feet to a point; thence continuing by land now or formerly of the Commonwealth of Massachusetts by 19 courses as follows:

N 40° 51' 40" W, a distance of 59.18 feet to a point,

N 37° 55' 55" W, a distance of 31.65 feet to a point,

N 29° 43' 39" W, a distance of 47.04 feet to a point,

N 25° 59' 51" W, a distance of 18.34 feet to a point,

N 26° 07' 46" W, a distance of 147.13 feet to a point,

N 57° 28' 20" W, a distance of 0.73 feet to a point,

N 22° 42' 54" W, a distance of 48.48 feet to a point,

N 21° 32' 50" W, a distance of 20.27 feet to a point,

N 14° 11' 07" W, a distance of 141 feet to a point,

N 04° 08' 34" E, a distance of 60.21 feet to a point,

N 10° 37' 49" W, a distance of 66.11 feet to a point,

N 10° 13' 54" W, a distance of 42.29 feet to a point,

N 19° 09' 50" W, a distance of 17.85 feet to a point,

N 19° 17' 12" W, a distance of 59.17 feet to a point,

N 24° 17' 55" W, a distance of 43.27 feet to a point,

N 29° 51' 29" W, a distance of 45.82 feet to a point,

N 33° 34' 42" W, a distance of 36.78 feet to a point,

N 40° 05' 46" W, a distance of 80.63 feet to a point, and

N 40° 40' 59" W, a distance of 58.49 feet to a drill hole with lead plug and brass pin found at the intersection with the southerly line of Pawtucket Street; thence

N 50° 30' 01" E, along the southerly line of Pawtucket Street, a distance of 6 feet, more or less, to the westerly face of a granite wall on the westerly side of the Pawtucket Canal; thence

SOUTHERLY, more or less, along the westerly face of the aforementioned wall, a distance of 45 feet, more or less, to the end of the wall; thence continuing

SOUTHERLY, more or less, along the westerly bank of the Pawtucket Canal a distance of 1,281 feet to a granite wall; thence continuing

SOUTHERLY, more or less, along the westerly face of said granite wall a distance of 81 feet, more or less, to a drill hole set along the westerly face of the granite wall at the top of a set of concrete steps; thence

S 27° 16' 45" E, along the westerly face of the aforementioned granite wall, a distance of 40.79 feet to the northerly face of a building known as the Locking Gate House; thence

S 62° 43' 24" W, along the northerly face of the aforementioned building a distance of 7.80 feet to a building corner; thence

S 27° 16' 45" E, along the westerly face of the aforementioned building a distance of 16.06 feet to a building corner; thence

N 62° 43' 24" E, along the southerly face of the aforementioned building a distance of 6 feet, more or less, to the westerly face of a granite wall on the westerly side of the Pawtucket Canal; thence

SOUTHERLY, more or less, along the aforementioned wall a distance of 55 feet more or less to the northwesterly corner of a building known as the Francis Gate House; thence

S 27° 26' 58" E, along the westerly face of the Francis Gate House a distance of 13.41 feet to the southwesterly corner of the Francis Gate House; thence by the westerly face of a granite wall on the westerly side of the Pawtucket Canal by five courses as follows:

SOUTHERLY, 12 feet, more or less,

WESTERLY, 13 feet, more or less,

SOUTHERLY, 3 feet, more or less,

EASTERLY, 16 feet, more or less, and

SOUTHERLY, 6.4 feet, more or less, to an iron pin set at the westerly face of said wall; thence continuing

SOUTHERLY, more or less, along the westerly face of the aforementioned wall 51 feet, more or less, to an angle point in the wall; thence continuing

SOUTHERLY, more or less, along said wall a distance of 25 feet, more or less, to an iron pin set at the westerly face of said wall, said iron pin being 75.37 feet on a bearing of S 21° 00' 01" E, from the last mentioned iron pin; thence

SOUTHWESTERLY, more or less, along the westerly face of the aforementioned granite wall a distance of 28 feet, more or less to the northerly line of Broadway; thence

S 82° 56' 05" W, along Broadway a distance of 22 feet, more or less, to the point of beginning.

Containing 37,500 square feet of land, more or less.

Being shown as Parcel 8B on sheets 2, 3 and 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 24 May 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 0.9 of an acre, more or less

Interest: Easement

Date: February 1, 1994

TRACT 110-06

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal so called, and known and numbered as 380 School Street and 577.2 Middlesex Place and further bounded and described as follows:

Beginning at a point on the easterly line of School Street, said point being the northeasterly corner of Parcel CB-A/4 as shown on sheet 8 of the plan hereinafter described; thence

S 64° 34' 09" E, a distance of 2.24 feet to an x-cut set at the back edge of the southerly granite wall of the Pawtucket Canal; thence running along the back edge of said canal wall as follows:

S 59° 30' 00" E, a distance of 105.94 feet to an x-cut set,

S 63° 37' 19" E, a distance of 193.60 feet to an x-cut set,

S 73° 36' 36" E, a distance of 97.13 feet to an x-cut set,

S 73° 37' 46" E, a distance 731.97 feet to an x-cut set,

EASTERLY, more or less, by a curve to the left of a distance of 177 feet, more or less, to a drill hole set,

EASTERLY, more or less, still by said curve, a distance of 299 feet, more or less to an iron pin set,

NORTHEASTERLY, more or less, by a curve to the left, a distance of 148 feet, more or less, to an x-cut set, and

N 57° 32' 42" E, a distance 249.31 feet to a point at the northwesterly corner of Parcel 2B/2C-1/2C-2 as shown on sheet 9 of said plan; thence along the southeasterly line of Parcel 2B/2C-1/2C-2 and land now or formerly of Thomas M. Hughes

S 22° 45' 06" E, a distance of 108.06 feet to a point at an angle in the northerly line of Middlesex Place

S 68° 00' 59" W, a distance of 25 feet to a point at the southeasterly corner of land now or formerly of John A. and Sandra L. Crowe; thence along the easterly line of Crowe

N 22° 45' 06" W, a distance of 85.36 feet to a point; thence along the northerly line of Crowe

S 57° 20' 02" W, a distance of 277.58 feet to a point at land now or formerly of Philip J. Stratos; thence along the northerly line of said Stratos

S 60° 05' 29" W, a distance of 104.53 feet to a point of curvature; thence along the northerly line of land now or formerly of said Stratos, Peter D. Hallissy and Lowell Boys Club Association

SOUTHWESTERLY, more or less, by a curve to the right having a radius of 616 feet, an arc length of 501.72 feet to a point at the northwesterly corner of land now or formerly of said Lowell Boys Club Association; thence along the westerly line of the Lowell Boys Club Association

S 16° 16' 54" E, a distance of 5 feet to a point at land now or formerly of Josephine M. Brady; thence along the northerly line of Brady as follows:

N 71° 50' 47" W, a distance of 52.05 feet to a point,

N 71° 59' 55" W, a distance of 168.82 feet to a point, and

N 73° 44' 25" W, a distance of 289.62 feet to a point at land now or formerly of Donald A. Delmore; thence by the northerly line of said Delmore and of land now or formerly of Ronald E. and Denise E. Belley, as follows:

N 73° 44' 25" W, a distance of 291.65 feet to a point,

N 63° 41' 05" W, a distance of 198.65 feet to a point, and

N 59° 37' 45" W, a distance of 93.37 feet to a point on the easterly line of School Street; thence along said easterly line of School Street

N 09° 18' 05" W, a distance of 23.58 feet to the point of beginning.

Containing 39,000 square feet of land, more or less, which is 0.9 of an acre, more or less.

Being shown as Parcel CB-A/5 on sheets 8 and 9 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 5 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 0.52 of an acre, more or less

Interest: Easement

Date: February 1, 1994

TRACT 110-07

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal so called, and known and numbered as 379 School Street and further bounded and described as follows:

Beginning at the northwesterly corner of the parcel, said corner being a point on the southerly line of location of the Boston and Maine Railroad, and being at the northeasterly corner of Parcel CB-A/2 as shown on the plan hereinafter described; thence along the southerly location line of said railroad

N 86° 50' 03" E, a distance of 71.11 feet to a point at the back edge of the southerly granite wall of the Pawtucket Canal; thence running along the back edge of said canal wall as follows:

S 43° 21' 58" E, a distance of 64.39 feet to an iron pin set,

S 56° 00' 37" E, a distance of 45.26 feet to an x-cut set,

S 59° 03' 48" E, a distance of 95.68 feet to a point,

S 58° 56' 41" E, a distance of 86.22 feet to a drill hole set,

WESTERLY, more or less, by a curve to the left a distance of 207 feet, more or less, to a drill hole set,

S 84° 07' 29" E, a distance of 133.92 feet to a drill hole set,

S 88° 59' 18" E, a distance of 29.40 feet to a drill hole set,

S 89° 44' 14" E, a distance of 42.79 feet to a drill hole set,

N 87° 29' 24" E, a distance of 39.60 feet to a drill hole set,

N 83° 30' 57" E, a distance of 103.57 feet to an x-cut set,

N 83° 29' 15" E, a distance of 62.46 feet to an x-cut set, and

S 85° 49' 54" E, a distance of 118.37 feet to an x-cut set, and

SOUTHEASTERLY, more or less, by a curve to the right a distance of 59 feet, more or less, to an x-cut set; thence

S 64° 34' 09" E, a distance of 6.16 feet to a point on the westerly line of School Street; thence along said westerly line of School Street

S 09° 18' 05" E, a distance of 22.36 feet to a point at land now or formerly of Marinel Transportation Inc.; thence along the northerly line of land of Marinel Transportation, Inc. and land of Nicholas C. Sarris et. al. as follows:

N 73° 27' 35" W, a distance of 93.55 feet to a point,

N 85° 19' 55" W, a distance of 68 feet to a point of curvature,

WESTERLY, more or less, by a curve to the right having a radius of 122 feet, an arc length of 25.20 feet to a point,

S 83° 30' 25" W, a distance of 160 feet to a point of curvature,

WESTERLY, more or less, by a curve to the right having a radius of 447 feet, an arc length of 52.03 feet to a point,

N 89° 48' 15" W, a distance of 50 feet to a point of curvature,

WESTERLY, more or less, by a curve to the right having a radius of 626 feet, an arc length of 76.05 feet to a point,

N 83° 13' 35" W, a distance of 80 feet to a point of curvature, and

NORTHWESTERLY, more or less, by a curve to the right having a radius of 550.22 feet, an arc length of 187.46 feet to a point at the end of a twenty foot wide private way; thence crossing the end of said private way

N 64° 26' 11" W, a distance of 28.22 feet to the southeasterly corner of land now or formerly of P.H. Macheras Oil Company; thence along the northeasterly line of land of said P.H. Macheras Oil Company by two courses as follows:

N 58° 56' 27" W, a distance of 292.59 feet to a point, and

N 71° 55' 57" W, a distance of 45.70 feet to a point at the southeasterly corner of Parcel CB-A/2 as shown on the plan herinafter described; thence along the easterly line of land of said Parcel CB-A/2

N 03° 30' 25" W, a distance of 12.54 feet to the point of beginning.

Containing 22,500 square feet of land, more or less, which is 0.52 of an acre, more or less.

Being shown as Parcel CB-A/3 on sheet 7 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 5 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 80 square feet, more or less

Interest: Easement

Date: April 12, 1994

TRACT 110-09

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal, so called, located near the railroad bridge commonly known as "Red Bridge" and further bounded and described as follows:

Beginning at a point on the southerly line of location of the Boston and Maine Railroad, said point being the northeasterly corner of land now or formerly of P.H. Macheras Oil company; thence along said railroad location line

N 86° 50' 03" E, a distance of 20.20 feet to a point at land now or formerly of the City of Lowell; thence along the westerly line of land of the City of Lowell

S 03° 30' 25" E, a distance of 7.87 feet to a point on the northerly line of land now or formerly of P.H. Macheras Oil Company; thence along said northerly line of P.H. Macheras Oil Company

N 71° 55' 57" W, a distance of 21.72 feet to the point of beginning.

Containing 80 square feet of land, more or less.

Being shown as Parcel CB-A/1 on sheet 7 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 5 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 1,030 square feet, more or less

Interest: Easement

Date: February 2, 1994

TRACT 110-14

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal, so called, and below the School Street bridge and further bounded and described as follows:

Beginning at the northwesterly corner of the parcel, said corner being a point on the westerly line of School Street; thence crossing said School Street

S 64° 34' 09" E, a distance of 58.41 feet to a point on the easterly line of School Street; thence along said easterly line of School Street

S 09° 18' 05" E, a distance of 20.25 feet to the corner of the concrete bridge abutment; thence crossing School Street by the face of said bridge abutment

N 66° 18' 20" W, a distance of 57.23 feet to a point on the westerly line of School Street, said point being at the northeasterly corner of land now or formerly of Marinel Transportation, Inc.; thence along said westerly line of School Street

N 09° 18' 05" W, a distance of 22.36 feet to the point of beginning.

Containing 1,030 square feet of land, more or less.

Being shown as Parcel CB-A/4 on sheet 7 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 5 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

EXHIBIT A

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 39,335 square feet, more or less

Interest: Easement

Date: August 22, 1994

TRACT 110-20

The following six parcels of land, together with the buildings thereon, located on the Pawtucket Canal, in Lowell, Middlesex County, Massachusetts between Pawtucket Street and Broadway Street and further bounded and described as follows:

PARCEL I:

Beginning at an iron pin set at the most northerly corner of the parcel, said pin being set at the back edge of the granite wall of the Pawtucket Canal, thence running along the exposed back edge of said wall

S 70° 45' 09" E, a distance of 51.24 feet to an iron pin set; thence continuing along the exposed back edge of said wall by three courses as follows:

SOUTHEASTERLY, more or less, a distance of about 37 feet to a chisel-cut set in the wall, said chisel-cut bearing S 45° 23' 13" E, and being 34.88 feet distant from the last point described,

SOUTHWESTERLY, more or less, a distance of about 3 feet, and

SOUTHERLY, more or less, a distance of about 4 feet to the most westerly corner of the Hydraulic Gatehouse, said corner bearing S 07° 38' 47" W, and being 5.59 feet distant from the last mentioned chisel-cut; thence along the southwesterly face of the Hydraulic Gatehouse

S 20° 48' 37" E, a distance of 19.39 feet to the most southerly corner of said Gatehouse; thence running along the southerly face of the Hydraulic Gatehouse

N 69° 11' 23" E, a distance of 4 feet, more or less, to a point; thence running perpendicular to the last mentioned course

SOUTHERLY, more or less, a distance of about 13 feet to a point on the westerly edge of a stone wall; thence running along the edge of said wall as follows:

SOUTHWESTERLY, more or less, a distance of about 22 feet to a point,

SOUTHEASTERLY, more or less, a distance of about 3 feet to a point,

NORTHEASTERLY, more or less, a distance of about 18 feet to a point, and

SOUTHERLY, more or less, a distance of about 41 feet to a drill hole set at the back of exposed edge of said wall, said drill hole bearing S 13° 10' 24" E, and being 58.36 feet distant from the aforementioned southwesterly corner of the Hydraulic Gatehouse; thence continuing along the back edge of the exposed wall as follows:

S 19° 32' 24" W, a distance of 23.95 feet to an iron pin set,

S 88° 10' 35" W, a distance of 11.14 feet to an iron pin set,

N 29° 55' 13" W, a distance of 13.01 feet to an iron pin set,

N 35° 19' 04" W, a distance of 12.82 feet to an iron pin set, and

N 11° 33' 48" W, a distance of 18.18 feet to a drill hole set; thence continuing along the edge of exposed wall:

NORTHEASTERLY, more or less, a distance of about 14 feet to a point,

NORTHWESTERLY, more or less, a distance of about 3 feet to a point,

SOUTHWESTERLY, more or less, a distance of about 14 feet to a point,

NORTHWESTERLY, more or less, a distance of about 12 feet to the southeasterly corner of the Francis Gatehouse, said corner bearing N 36° 56' 54" W, and being 15.26 feet distant from the last mentioned drill hole; thence running along the northeasterly face of the Francis Gatehouse

N 27° 26' 58" W, a distance of 13.41 feet to the northeasterly corner thereof; thence running along the back of the exposed granite wall

N 17° 56' 25" W, a distance of 9.09 feet to a drill hole set in the bottom step of some granite steps; thence continuing along the back edge of the wall

NORTHWESTERLY, more or less, a distance of about 32 feet to a point on the southerly wall of the Locking Gatehouse; thence running along the face of the north end of the Gatehouse as follows:

N 62° 43' 24" E, a distance of 7 feet to the northeasterly corner of the Gatehouse,

N 27° 16' 45" W, a distance of 16.06 feet to the northerly corner of the Gatehouse,

S 62° 43' 24" W, a distance of about 8.7 feet to a point on the northerly face of the Locking Gatehouse, said point being at the back of the exposed granite wall as hereinbefore mentioned; thence running along the back of said wall

NORTHWESTERLY, more or less, a distance of about 0.7 feet to a drill hole set, said drill hole bearing S 66° 57' 39" W, and being 8.71 feet distant from the aforementioned northerly corner of the Locking Gatehouse; thence continuing along the back edge of said wall

N 22° 50' 38" W, a distance of 32.98 feet to the point of beginning.

Containing 5,660 square feet of land, more or less.

Being shown as Parcel 8-C on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

PARCEL II:

Beginning at an iron pin set at the northwesterly corner of Broadway and Madonna Circle; thence along the northerly line of Broadway

S 82° 56' 05" W, a distance of about 70 feet to a point at the back edge of the easterly granite wall of the Pawtucket Canal; thence along the back edge of said canal wall

NORTHERLY, more or less, a distance of about 163 feet to an angle in said wall; thence along the back edge of a granite wall appurtenant to the Pawtucket Canal as follows:

SOUTHEASTERLY, more or less, a distance of about 26 feet,

NORTHEASTERLY, more or less, a distance of about 3 feet, and

NORTHWESTERLY, and WESTERLY, more or less, a distance of about 94 feet to a point on said wall at Parcel 8-C, as described above; thence along the easterly line of Parcel 8-C

NORTHERLY, more or less, a distance of about 13 feet to the southerly face of the Hydraulic Gatehouse; thence by the face of said gatehouse

N 69° 11' 23" E, a distance of about 67 feet to the southeasterly corner thereof, and

N 20° 48' 37" W, a distance of 19.39 feet to the northeast corner of said gatehouse; thence along the edge of the easterly granite wall of the Pawtucket Canal as follows:

NORTHERLY, more or less, a distance of about 96 feet,

WESTERLY, more or less, a distance of about 3 feet, and

SOUTHERLY, more or less, a distance of about 38 feet to a point on the easterly shoreline of aforesaid Pawtucket Canal; thence along said easterly shoreline

NORTHWESTERLY, more or less, a distance of about 1,464 feet to a point at the back edge of the easterly granite wall of said Pawtucket Canal; thence along said canal wall

NORTHWESTERLY, more or less a distance of about 26 feet to a point on the southerly line of Pawtucket Street; thence along said line of Pawtucket Street

N 50° 30' 01" E, a distance of about 24 feet to an iron pin set at land now or formerly of the City of Lowell; thence along the westerly line of land of said City of Lowell as follows:

S 42° 57' 18" E, a distance of 18.50 feet to an iron pin set,

S 52° 22' 18" E, a distance of 45.33 feet to a drill hole set,

S 51° 03' 18" E, a distance of 26.92 feet to an iron pin set,

S 45° 57' 08" E, a distance of 99.63 feet to an iron pin set,

S 27° 45' 08" E, a distance of 9.13 feet to a point,

S 23° 43' 08" E, a distance of 166.68 feet to a drill hole set,

S 20° 16' 08" E, a distance of 18.32 feet to a drill hole set,

S 06° 36' 38" E, a distance of 108.50 feet to an iron pin set,

S 11° 40' 38" E, a distance of 236.01 feet to an iron pin set,

S 17° 29' 58" E, a distance of 36.11 feet to an iron pin set,

S 22° 11' 38" E, a distance of 36.39 feet to an iron pin set,

S 30° 12' 38" E, a distance of 131.48 feet to a drill hole in a stone bound found,

S 30° 12' 38" E, a distance of 100.00 feet to a drill hole in a stone bound found,

S 30° 12' 37" E, a distance of 53.52 feet to a drill hole in a stone bound found,

SOUTHEASTERLY, more or less, by a curve to the left having a radius of 212.80 feet, an arc length of 39.25 feet to a drill hole in a stone bound found, and

S 40° 46' 41" E, a distance of 60.26 feet to a point at land now or formerly of Thomas Riley; thence along the southwesterly line of Riley as follows:

S 40° 46' 41: E, a distance of 91.60 feet to a drill hole in a stone bound found,

S 51° 27' 21" E, a distance of 93.41 feet to a point, and

S 55° 19' 01" E, a distance of 108.23 feet to a P.K. nail set at Madonna Circle; thence along the westerly line of Madonna circle

S 11° 00' 40" E, a distance of 253.76 feet to the point of beginning.

Meaning and intending to exclude the canal walls of the Pawtucket Canal.

Containing 26,200 square feet of land, more or less.

Being shown as Parcel 13B on sheets 2, 3, and 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

PARCEL III:

Beginning at the southeasterly corner of the Hydraulic Gatehouse, said corner being 20.43 feet distant from the westerly line of Madonna Circle; thence along the southerly wall of the gatehouse by Parcel 13B and Parcel 8-C

S 69° 11' 23" W, a distance of 71.00 feet to the southwest corner thereof; thence along the westerly wall of the gatehouse, by Parcel 8-C

N 20° 48' 37" W, a distance of 19.39 feet to the northwest corner thereof; thence along the northerly wall of the gatehouse by Parcel 8-C and crossing the Pawtucket Canal

N 69° 11' 23" E, a distance of 71.00 feet to the northeast corner thereof; thence along the easterly wall of the gatehouse

S 20° 48' 37" E, a distance of 19.39 feet to the point of beginning.

Containing 1,377 square feet of land, more or less.

Being shown as Hydraulic Gatehouse - Guard Locks, on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

PARCEL IV:

Beginning at the most northwesterly corner of the Francis Gatehouse, said corner being 19.34 feet distant from the northeasterly line of Parcel 8-A, Lot 1 and being on the easterly line of Parcel 8B as shown on the Plan hereinafter described; thence

N 62° 17' 23" E, along the northerly face of the Francis Gatehouse and across the lock chamber, a distance of 36.60 feet to the most northerly corner thereof; thence running along the easterly building face

S 27° 26' 58" E, a distance of 13.41 feet to the southeasterly corner of said Francis Gatehouse; thence running along the southerly building face, and again crossing the lock chamber

S 62° 17' 23" W, a distance of 36.60 feet to the southeast building corner; thence running along the westerly building face, being the easterly line of Parcel 8B,

N 27° 26' 58" W, a distance of 13.41 feet to the point of beginning.

Containing 491 square feet of land, more or less.

Being shown as Francis Gatehouse on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

PARCEL V:

Beginning at the most southwesterly corner of the Locking Gatehouse, said point being 12.64 feet distant from the easterly line of Parcel 8A, Lot 1, as shown on the Plan hereinafter described, and being on the easterly line of Parcel 8B; thence

N 27° 16' 45" W, along Parcel 8B, a distance of 16.06 feet to a building corner; thence

N 62° 43' 24" E, along the northerly face of the building, crossing over the lock chamber and by part of Parcel 8-C to the most northeasterly building corner a distance of 51.29 feet; thence

S 27° 16' 45" E, along the most easterly face of said building a distance of 16.06 feet to a corner; thence

S 62° 43' 24" W, along the face of said building a distance of 7.89 feet to a corner; thence

S 27° 16' 45" E, along the face of said building a distance of 8.00 feet to the most southeasterly corner of said building; thence

S 62° 43' 24" W, along the most southerly face of said building a distance of 35.40 feet to a corner; thence

N 27° 16' 45" W, along the face of said building a distance of 8.00 feet to a corner; thence

S 62° 43' 24" W, along the face of said building a distance of 8.00 feet to the point of beginning.

Containing 1,000 square feet of land, more or less.

Being shown as Locking Gatehouse on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

PARCEL VI:

Beginning at a drill hole set at the northwesterly corner of the parcel along the westerly face of the westerly granite lock chamber wall at the top of a set of granite steps; thence

S 27° 16' 45" E, along the westerly face of the aforementioned granite wall, a distance of 40.79 feet to the northerly face of a building known as the Locking Gatehouse; thence

S 62° 43' 24" W, along the northerly face of the aforementioned building a distance of 7.80 feet to a building corner; thence

S 27° 16' 45" E, along the westerly face of the aforementioned building a distance of 16.06 feet to a building corner; thence

N 62° 43' 24" E, along the southerly face of the aforementioned building a distance of about 6 feet to the westerly face of a granite wall on the westerly side of the Pawtucket Canal; thence

SOUTHERLY, more or less, along the aforementioned wall a distance of about 55 feet to the northwesterly corner of a building known as Francis Gatehouse; thence

S 27° 26' 58" E, along the westerly face of the Francis Gatehouse a distance of 13.41 feet to the southwesterly corner of the Francis Gatehouse; thence by the westerly face of a granite wall on the westerly side of the Pawtucket Canal by 5 courses as follows:

SOUTHERLY, about 12 feet,

WESTERLY, about 13 feet,

SOUTHERLY, about 3 feet,

EASTERLY, about 16 feet, and

SOUTHERLY, about 6.4 feet to an iron pin set at the westerly face of said wall; thence continuing

SOUTHERLY, more or less, along the westerly face of the aforementioned wall about 51 feet to an angle point in the wall; thence continuing

SOUTHERLY, more or less, along said wall a distance of about 25 feet to an iron pin set at the westerly face of said wall, said iron pin being 75.37 feet on a bearing of S 21° 00' 01" E, from the last mentioned iron pin; thence

NORTHEASTERLY, N 30° 24' 34" E, a distance of 62.37 feet to an iron pin set,

S 88° 10' 35" W, a distance of 11.14 feet to an iron pin set,

N 29 ° 55' 13" W, a distance of 13.01 feet to an iron pin set,

N 35° 19' 04" W, a distance of 12.82 feet to an iron pin set, and

N 11° 33' 48" W, a distance of 18.18 feet to a drill hole set; thence continuing along the edge of exposed wall;

NORTHEASTERLY, more or less, a distance of about 14 feet to a point,

NORTHWESTERLY, more or less, a distance of about 3 feet to a point,

SOUTHWESTERLY, more or less, a distance of about 14 feet to a point,

NORTHWESTERLY, more or less, a distance of about 12 feet to the southeasterly corner of the Francis Gatehouse, said corner bearing N 36° 56' 54" W, and being 15.26 feet distant from the last mentioned drill hole; thence running along the northeasterly face of the Francis Gatehouse

N 27° 26' 58" W, a distance of 13.41 feet to the northeasterly corner thereof; thence running along the back of the exposed granite wall

N 17° 56' 25" W, a distance of 9.09 feet to a drill hole set in the bottom step of some granite steps; thence continuing along the back edge of the wall

NORTHWESTERLY, more or less, a distance of about 32 feet to a point on the southerly wall of the Locking Gatehouse; thence running along the face of the north end of the Gatehouse as follows:

N 62° 43' 24" E, a distance of about 7 feet to the northeasterly corner of the Gatehouse,

N 27° 16' 45" W, a distance of 16.06 feet to the northerly corner of the Gatehouse,

S 62° 43' 24" W, a distance of about 8.7 feet to a point on the northerly face of the Locking Gatehouse, said point being at the back of the exposed granite wall as hereinbefore mentioned; thence running along the back of said wall

NORTHWESTERLY, more or less, a distance of about 0.7 feet to a drill hole set, said drill hole bearing S 66° 57' 39" W, and being 8.71 feet distant from the aforementioned northerly corner of the Locking Gatehouse; thence continuing along the back edge of said wall

N 22° 50' 38" W, a distance of 32.98 feet to a point, thence

WESTERLY, S 73° 44' 18" W, a distance of 38.05 feet to the point of beginning.

Containing 5,984 square feet of land, more or less.

Being shown as Guard Locks - Lock Chamber, on sheet 4 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

All six parcels are a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with the Middlesex Northern District Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 2,839 square feet, more or less

Interest: Easement

Date: January 27, 1994

TRACT 111-09

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Western Canal, so called, known and numbered as 501 Dutton Street and further bounded and described as follows:

Beginning at the northwesterly corner of Dutton Street and Hayden Street, said corner being the southeasterly corner of the parcel described; thence along the northwesterly line of Hayden Street

S 80° 30' 30" W, a distance of 150.82 feet to the easterly line of Worthen Street; thence along said Worthen Street

N 09° 34' 16" W, a distance of 17.24 feet to a point at the back edge of the southeasterly granite wall of the Western canal; thence along said canal wall

N 80° 23' 13" E, a distance of 154.75 feet to a point on the westerly line of Dutton Street; thence along said Dutton Street

SOUTHERLY, more or less, by a curve to the right having a radius of 1,210.46 feet, an arc length of 18.01 feet, to the point of beginning.

Containing 2,839 square feet of land, more or less.

Being shown as Parcel 24 on sheet 29 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 6 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 0.23 of an acre, more or less

Interest: Easement

Date: February 2, 1994

TRACT 111-17

Four certain parcels of land located in Lowell, Middlesex County, Massachusetts along the Hamilton Canal, so called, and known and numbered as 171.1 Jackson Street and further bounded and described as follows:

PARCEL I:

Beginning at the southwesterly corner of the parcel, said corner bearing N 12° 38' 52" W, and being 23 feet distant from the northerly line of Jackson Street; thence running along the easterly line of land now or formerly of James T. Lichoulas, Trustee of Appleton Trust

N 12° 38' 52" W, a distance of 10.91 feet to a cut set at the face of a concrete wall; thence running along the southerly line of land now or formerly of the Proprietors of Locks and Canals and along said wall

N 84° 56' 46" E, a distance of 48.75 feet to a drill hole set at the corner of said wall; thence running along the easterly line of land now or formerly of the Proprietors of Locks and Canals

N 02° 30' 39" E, a distance of 17.68 feet to a point at the Hamilton Canal; thence running along the southerly side of the Hamilton Canal

N 86° 56' 46" E, a distance of 64.37 feet to a point on the northwesterly line of Parcel 5345C, as hereinafter described; thence running along said northwesterly line of Parcel 5345C by two courses as follows:

SOUTHWESTERLY, more or less, by a curve to the right having a radius of 142 feet, an arc length of 18.55 feet to a point of compound curvature, and

SOUTHWESTERLY, more or less, by a curve to the right having a radius of 98 feet, an arc length of 34 feet to a point at the southeasterly corner of Parcel 5345B as hereinafter described; thence running along the easterly line of Parcel 5345B

N 12° 38' 52" W, a distance of 5.50 feet to a point; thence running along the northerly line of Parcel 5345B, said line being 23 feet distant from and parallel with the northerly line of Jackson Street

S 77° 21' 08" W, a distance of 67 feet to the point of beginning.

Containing 1,438 square feet of land, more or less.

Being shown as Parcel 5345A on sheet 15 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 29 June 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

PARCEL II:

Beginning at the northwesterly corner of the parcel, said corner being the southwesterly corner of Parcel 5345A as hereinbefore described; thence running along the southerly and easterly line of Parcel 5345A by two courses as follows:

N 77° 21' 08" E, a distance of 67 feet to a point, and

S 12° 38' 52" E, a distance of 5.50 feet to a point at land now or formerly of James T. Lichoulas, Trustee of Appleton Trust; thence running by land now or formerly of said James T. Lichoulas

S 77° 21' 08" W, a distance of 67 feet to a point on the easterly line of other land owned now or formerly by James T. Lichoulas, Trustee of Appleton Trust; thence along said easterly line of Lichoulas

N 12° 38' 52" W, a distance of 5.50 feet to the point of beginning.

Containing 368.5 square feet of land, more or less.

Being shown as Parcel 5345B on sheet 15 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 29 June 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

PARCEL III:

Beginning at the southwesterly corner of the parcel, said corner being the southeasterly corner of parcel 5345B as hereinbefore described; thence along the southerly line of Parcel 5345A by two courses as follows:

NORTHEASTERLY, more or less, by a curve to the left having a radius of 98 feet, an arc length of 34 feet to a point of compound curvature; and

NORTHEASTERLY, more or less, by a curve to the left having a radius of 142 feet, an arc length of 19.29 feet to a point at the Hamilton Canal; thence along the southerly line of said Hamilton Canal

N 77° 21' 08" E, a distance of 45 feet to a point; thence by land now or formerly of the Proprietors of Locks and Canals

S 20° 51' 08" W, a distance of 20 feet to a point on the northerly line of land now or formerly of James T. Lichoulas, Trustee of Appleton Trust; thence along said northerly line of Lichoulas

S 77° 21' 08" W, a distance of 84 feet to the point of beginning.

Containing 960 square feet of land, more or less.

Being shown as Parcel 5345C on sheet 15 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 29 June 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

PARCEL IV:

Beginning at the southwesterly corner of the parcel, said point being the southeasterly corner of Parcel 5345C as hereinbefore described; thence along the easterly line of Parcel 5345C

N 20° 51' 08" E, a distance of 17.87 feet to a point at the Hamilton Canal; thence running along the back edge of the southerly wall of said canal by five courses as follows:

N 77° 46' 01" E, a distance of 33.52 feet to a punch mark set at the edge of a steel bridge girder,

N 76° 53' 30" E, a distance of 21.79 feet to another punch mark set at the edge of a steel bridge girder,

N 77° 18' 27" E, a distance of 59.96 feet to a cut set at the back edge of the wall,

N 77° 29' 54" E, a distance of 256.02 feet to a drill hole set at the back edge of the wall,

N 76° 33' 10" E, a distance of 107.84 feet to a point at land now or formerly of Courier Citizen company; thence by the westerly line of land of said Courier Citizen Company

S 12° 38' 52" E, a distance of 15.80 feet to a point at land now or formerly of James T. Lichoulas, Trustee of Appleton Trust; thence running by the northerly line of land of said James T. Lichoulas, Trustee

S 77° 21' 08" W, a distance of 588.99 feet to the point of beginning.

Containing 8,637 square feet of land, more or less.

Being shown as Parcel 5345D on sheet 15 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic

Engineering and Survey Consultants, dated 29 June 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Interest: Easement

Date: April 14, 1994

TRACT 111-22

A certain parcel of land located southerly of the Western Canal, so called, and also located southerly of a certain parcel of land known and numbered 501 Dutton Street, being a portion of Hayden Street, in the City of Lowell, County of Middlesex and Commonwealth of Massachusetts, and further bounded and described as follows:

Beginning at a point at the intersection of the Northwesterly line of Hayden Street with the Northerly line of Worthen Street, said point being the Southerly corner of the parcel known as 501 Dutton Street, being owned by the Commonwealth of Massachusetts;

Thence, turning and running Northeasterly along said land of the Commonwealth of Massachusetts a distance of 150.82 feet, more or less to the Westerly line of Dutton Street;

Thence, turning and running along said line of Dutton Street 10 feet, more or less to a point in the middle of Hayden Street;

Thence, turning and running Southwesterly in a straight line to a point located at the intersection of Hayden Street with the Northerly line of Worthen Street;

Thence, turning and running along said Worthen Street a distance of 10 feet, more or less, to the point of beginning.

The above described land is shown on the following plans:

Sheet 29 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 6 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69; and

Sheet 4 of a set of plans entitled "The Commonwealth of Massachusetts Plan of Road in the City of Lowell, Middlesex County Laid Out as a City Highway by the Department of Public Works" and prepared by Howard, Needles, Tammen & Bergendoff, dated September 25, 1985 and recorded with said Registry of Deeds in Plan Book 150, Plan 53.

Said property being owned by the Commonwealth of Massachusetts by virtue of its Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 7,597 square feet, more or less

Interest: Easement

Date: January 27, 1994

TRACT 111-23

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Western Canal, so called, known and numbered as 139 Broadway and further bounded and described as follows:

Beginning at a drill hole set in the concrete sidewalk at the northeasterly corner of Suffolk Street and Broadway; thence running along the easterly line of Suffolk Street

N 11° 11' 30" W, a distance of 321.90 feet to a drill hole set at the southeasterly corner of Suffolk Street and Jefferson Street; thence running along the southerly line of Jefferson Street

N 78° 52' 10" E, a distance of 23.58 feet to a drill hole set on the westerly line of the Western Canal; thence running along the back edge of the concrete retaining wall of said Western Canal as follows:

S 11° 18' 00" E, a distance of 160.76 feet to a spike set, and

S 11° 11' 27" E, a distance of 161.69 feet to the northerly line of Broadway; thence running along said northerly line of Broadway

S 80° 04' 33" W, a distance of 23.88 feet to the point of beginning.

Containing 7,597 square feet of land, more or less.

Being shown as Parcel CB-C, Lot A on sheet 28 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 6 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 6,450 square feet, more or less

Interest: Easement

Date: January 27, 1994

TRACT 111-24

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Western Canal, so called, known and numbered as 125 Broadway and further bounded and described as follows:

Beginning at a drill hole set in the granite curb at the northwesterly corner of Broadway and Lewis Street; thence running along the northerly line of Broadway

S 80° 04' 33" W, a distance of 25 feet, more or less, to the easterly shoreline of the Western Canal; thence running along said easterly shoreline of the Western Canal

NORTHERLY, more or less, a distance of 328 feet, more or less, to a point on the southerly line of Jefferson Street; thence along said line of Jefferson Street

N 78° 52' 10" E, a distance of 24 feet, more or less, to a spike set at the corner of Lewis Street; thence running along the westerly line of Lewis Street

S 11° 11' 30" E, a distance of 324.02 feet to the point of beginning.

Containing 6,450 square feet of land, more or less.

Being shown as Parcel CB-D, Lot B on sheet 28 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 6 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 0.09 of an acre, more or less

Interest: Easement

Date: February 2, 1994

TRACT 111-26

A certain parcel of land located in Lowell, Middlesex County, Massachusetts along the Pawtucket Canal, so called, and further bounded and described as follows:

Beginning at an iron pin set at the most westerly corner of the parcel, said pin being at the northeasterly corner of Parcel CB-A, as shown on the plan hereinafter described, and being at the back edge of the southerly granite wall of the Pawtucket Canal; thence along the back edge of said canal wall

N 57° 32' 42" E, a distance of 42.67 feet to a point on the southwesterly location line of the Boston and Maine Railroad; thence along said railroad location line as follows:

SOUTHEASTERLY, more or less, by a curve to the right having a radius of 967.73 feet, an arc length of 41.01 feet to a point,

N 51° 44' 05" E, a distance of 10.85 feet to an iron pin set, and

SOUTHEASTERLY, more or less, by a curve to the right having a radius of 977.73 feet, an arc length of 21.57 feet to an iron pin set at land now or formerly of Thomas M. Hughes; thence along the northwesterly line of land of said Hughes

S 51 44' 05" W, a distance of 95.31 feet to a point on the easterly line of Parcel CB-A; thence along said easterly line of Parcel CB-A

N 22° 45' 06" W, a distance of 64.06 feet to the point of beginning.

Containing 4,011 square feet of land, more or less.

Being shown as Parcel 2B/2C-1/2C-2 on sheet 10 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 2 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 937 square feet, more or less

Interest: Easement

Date: February 3, 1994

TRACT 111-32

A certain parcel of land with buildings, improvements, structures and fixtures thereon, commonly known as the Swamp Locks Gate House, located in Lowell, Middlesex County, Massachusetts over the Lower Pawtucket Canal, so called, and further bounded and described as follows:

Beginning at the northwesterly corner of the parcel, said corner being a point along the southerly line of Parcel CB-G, as shown on the plan hereinafter described, bearing N 79° 49' 52" E, and being 3.15 feet distant from a drill hole set at an angle in the said southerly line of Parcel CB-G; thence along said line of Parcel CB-G

N 79° 49' 52" E, a distance of 3.52 feet to a point; thence running along the edge of a steel grate footbridge as shown on said plan

S 04° 25' 13" E, a distance of 64.47 feet to the northerly wall of the northerly gate house; thence running along the wall of said gate house as follows:

N 85° 34' 47" E, a distance of 11.22 feet to a corner,

S 04° 25' 13" E, a distance of 10.50 feet to a corner,

S 85° 34' 47" W, a distance of 9.75 feet to a corner and

S 04° 25' 13"E, a distance of 30.06 feet to a point 0.30 feet beyond the southeasterly corner of the northerly gate house; thence

S 85° 34' 20" W, a distance of 2 feet to a point 1.78 feet distant from the northeasterly corner of the southerly gate house and along the prolongation of the easterly wall thereof; thence running to and along the easterly wall of said southerly gate house as follows:

S 03° 45' 33" E, a distance of 20.14 feet to a corner,

S 86° 14' 27" W, a distance of 12.42 feet to a corner, and

N 03° 45' 33" W, a distance of 18.36 feet to a corner, and

N 86° 14' 27" E, a distance of 6.32 feet to a point on the northerly wall of said southerly gate house, said point being along the prolongation of the westerly wall of the northerly gate house, and 2.01 feet distant therefrom; thence running to and along the wall of said northerly gate house as follows:

N 04° 25' 13" W, a distance of 31.77 feet to a corner,

S 85° 34' 47" W, a distance of 3.93 feet to a corner,

N 04° 25' 13" W, a distance of 10.50 feet to a corner, and

N 85° 34' 47" E, a distance of 7.08 feet to a point on the northerly wall of the northerly gate house at the westerly edge of the steel grate footbridge; thence running along the westerly edge of said footbridge

N 04° 25' 13" W, a distance of 64.11 feet to the point of beginning.

Containing 937 square feet of land, more or less.

Being shown as Swamp Locks Gate House on sheet 12 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 2 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 875 square feet, more or less

Interest: Easement

Date: February 3, 1994

TRACT 111-33

Two certain parcels of land with improvements, structures and fixtures thereon, commonly known as the Swamp Locks Dam North and South, located in Lowell, Middlesex County, Massachusetts over the Lower Pawtucket Canal, so called, and further bounded and described as follows:

PARCEL I:

Beginning at the southeasterly corner of the dam, said corner being the northeasterly corner of the northerly gate house as shown on the plan hereinafter described; thence along the northerly wall of said northerly gate house

S 85° 34' 47" W, a distance of 14 feet, more or less, to the face of the dam, said face being about one foot easterly from and parallel with the westerly edge of the steel grate footbridge as shown on said plan; thence running along the face of the dam

N 04° 25' 13" W, a distance of 61 feet, more or less, to the face of a concrete wall; thence running along said concrete wall

EASTERLY, NORTHERLY and EASTERLY, all of said directions being more or less, a distance of 14 feet more or less to a point along the wall at the toe of the dam; thence running along the toe of the dam

S 04° 25' 13" E, a distance of 64 feet, more or less, to the point of beginning.

Containing 875 square feet of land, more or less.

PARCEL II:

Beginning at the northwesterly corner of the dam, said corner being 2.5 feet easterly from a westerly wall of the northerly gate house as shown on the plan hereinafter described; thence running along the northerly line of the dam, said line being along a southerly wall in the aforesaid northerly gate house

N 85° 34' 47" E, a distance of 28 feet, more or less, to the northeast corner of the dam; thence running across the toe of the dam

S 04° 25' 13" E, more or less, a distance of 30 feet, more or less, to the southeast corner of the dam; thence along the northerly face a granite wall

S 85° 34' W, more or less, a distance of 28 feet, more or less, to the southwest corner of the dam, said corner being a point on the southerly wall of aforesaid northerly gate house; thence running along the face of the dam, said face being 2.5 feet easterly from and parallel with a westerly wall of said gate house

N 04° 25' 13" W, a distance of 30 feet, more or less, to the point of beginning.

Containing 840 square feet of land, more or less.

Both Parcels I and II being shown as Swamp Locks Dam/North and Swamp Locks Dam/South on sheet 12 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 2 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 11,685 square feet, more or less

Interest: Easement

Date: February 3, 1994

TRACT 111-34

All that improvement and/or air rights with any structures and fixtures thereon, commonly known as the Swamp Locks Lock Chambers, located in Lowell, Middlesex County, Massachusetts over the Lower Pawtucket Canal, so called, and further bounded and described as follows:

Beginning at a cross-cut set at the most westerly corner of the parcel, said cross-cut being at the back edge of the southerly granite wall of the Pawtucket Canal and being on the northerly line of land of Parcel CB-I as shown on the plan hereinafter described; thence crossing the headwaters of the Swamp Locks and running

N 60° 11' 35" E, a distance of 45.57 feet to a cut set on the northerly face of a concrete buttress; thence along the northerly face of said buttress

N 86° 14' 27" E, a distance of 7.43 feet to the westerly face of the Swamp Locks Gate House; thence running along the walls of said Gate House:

S 03° 45' 33" E, a distance of 4.26 feet to a corner,

N 86° 14' 27" E, a distance of 12.42 feet to a corner, and

N 03° 45' 33" W, a distance of 1.17 feet to a point on the easterly wall of said Swamp Locks Gate House; continuing,

N 03° 45' 33" W, a distance of 18.96 feet to a point at the northerly face of the southerly granite wall of the Lower Pawtucket Canal; thence running along said granite wall as follows:

N 85° 34' 20" E, a distance of 46.21 feet to a cut set in the face of said wall,

N 84° 43' 16" E, a distance of 43.12 feet to a cut set in the face of said wall, and

N 89° 50' 16" E, a distance of 20.87 feet to a cut set in the face of said wall; thence running along the northerly face of the southerly granite wall of the Lower Pawtucket Canal and thence crossing a twenty foot passageway

N 86° 13' 40" E, a distance of 66.78 feet to a point on the easterly line of said twenty foot passageway; thence running along the easterly line of said twenty foot passageway

N 09° 30' 31" W, a distance of 3.95 feet to the southerly shoreline of the Lower Pawtucket Canal; thence running along said southerly shoreline as follows:

N 85° 27' 15" E, a distance of 41.46 feet to a point,

N 88° 55' 33" E, a distance of 80.01 feet to a point, and

S 06° 40' 48" E, a distance of 11.18 feet to a point at the bottom of the Swamp Locks Lower Lock Chamber; thence running along said Lower Lock Chamber

S 84° 08' 49" W, a distance of 48.05 feet to a point; thence running as follows:

S 00° 25' 22" E, a distance of 27.89 feet to a point on the northerly line of land now or formerly of the Pellon Corporation; thence along the line of said Pellon Corporation

S 77° 16' 35" W, a distance of 66.89 feet to a point on the easterly line of a twenty foot passageway leading to Jackson Street; thence along the easterly line of said passageway

N 13° 10' 56" W, a distance of 11.82 feet to a point at the southerly wall of the Swamp Locks Chamber; thence along the southerly wall of the Swamp Locks Lower Locks Chamber as follows:

S 81° 09' 40" W, a distance of 52.56 feet to a drill hole set in the face of a concrete wall, and

N 01° 48' 53" W, a distance of 7.55 feet to an iron pin set at the back edge of the southerly granite wall of the Swamp Locks Upper Chamber; thence running along the back edge of said granite wall as follows:

S 85° 46' 53" W, a distance of 139.78 feet

S 87° 04' 42" W, a distance of 49.47 feet to the point of beginning.

Containing 11,685 square feet of land, more or less.

Being shown as Swamp Locks-Lock Chamber on sheet 11 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 28 June 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 0.01 of an acre, more or less

Interest: Easement

Date: June 29, 1992
Revised: February 3, 1994

TRACT 112-01

A certain parcel of land with buildings, structures and fixtures, thereon, commonly known as the Hamilton Gate House, located in Lowell, Middlesex County, Massachusetts over the Hamilton Canal, so called, and near Jackson Street and further bounded and described as follows:

Beginning at a point on the westerly line of the Hamilton Canal at the head of the Hamilton Wasteway, said point bearing northeasterly, more or less, and being 21.05 feet distant from the southeasterly corner of a building foundation, thence running along the westerly face of the Hamilton Gate House by land now or formerly of John Adden Furniture, Inc. N 12° 40' 17" W, a distance of 12.18 feet to the northwesterly corner of the gate house, said corner bearing southeasterly more or less and being 20.40 feet distant from the northeasterly corner of a building foundation; thence running the following two courses along the northerly and easterly faces of the Hamilton Gate House, by land now or formerly of John Adden Furniture, Inc.;

N 77° 19' 43" E, a distance of 21.18 feet to the northeast corner of said gate house,

S 12° 40' 17" E, a distance of 12.18 feet to the southeast corner of said gate house;

Thence, running across the canal along the southerly face of the gate house, by land now or formerly of John Adden Furniture, Inc., S 77° 19' 43" W, a distance of 21.18 feet to the point of beginning.

Containing 258 square feet of land, which is 0.01 of an acre, more or less.

Being shown as the Hamilton Gate House on sheet 16 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

Being a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

EXHIBIT A

Purported Owner: Commonwealth of MA/DEM

Lowell Historic Preservation Commission

Area: 13,645 square feet, more or less

Interest: Easement

Date: August 18, 1994

TRACT 112-04

The following three parcels of land, with the buildings thereon, located in Lowell, Middlesex County, Massachusetts and more particularly bounded and described as follows:

PARCEL I:

A certain parcel of land located on the Pawtucket Canal, so called, in Lowell, Middlesex County, Massachusetts and commonly known as the Lower Locks Dam, and further bounded and described as follows:

Beginning at a point at the southwesterly corner of the parcel, said point being two feet distant from and parallel with the westerly face of the Lower Locks Gatehouse, as hereinafter described; thence crossing the Pawtucket Canal and running along the face of the Lower Locks Dam

N 06° 25' 46" E, a distance of 87 feet, more or less, to a point at the northerly end of the dam; thence running along the northerly end of the Lower Locks Dam

EASTERLY, more or less, a distance of about 41 feet to the base of said Dam; thence crossing the Pawtucket Canal and running across the base of the dam

SOUTHERLY, more or less, a distance of about 98 feet to a point at the base of granite of the Lower Locks; thence running along the southerly line of the Lower Locks Dam, being at the base of granite of said Lower Locks

WESTERLY, more or less, a distance of about 46 feet to the point of beginning.

Containing 3,680 square feet of land, more less.

PARCEL II:

The land, with the buildings thereon, located on the Pawtucket Canal in Lowell, Middlesex County, Massachusetts and commonly known as the Lower Locks Gatehouse, and further bounded and described as follows:

Beginning at the southwesterly corner of the Lower Locks Gatehouse, as shown on the Plan hereinafter described; thence running along the westerly face of the Gatehouse, more or less, and across the Pawtucket Canal, by five courses as follows:

N 06° 25' 46" E, a distance of 64.78 feet to a point,

N 83° 34' 14" W, a distance of 2.50 feet to a point,

N 06° 25' 46" E, a distance of 12.25 feet to a point,

S 83° 34' 14" E, a distance of 2.50 feet to a point, and

N 06° 25' 46" E, a distance of 18.10 feet to the northwesterly corner of the Gatehouse, being at land now or formerly of the City of Lowell and known as the Rex lot; thence along the northerly face of the Lower Locks Gatehouse by land now or formerly of the City of Lowell

S 83° 34' 14" E, a distance of 7.50 feet to the northeasterly corner of the Gatehouse; thence running along the easterly face of said Gatehouse, and crossing the Lower Locks Dam, by five courses as follows:

S 06° 25' 46" W, a distance of 18.10 feet to a point,

S 83° 34' 14" E, a distance of 7.70 feet to a point,

S 06° 25' 46" W, a distance of 12.25 feet to a point,

N 83° 34' 14" W, a distance of 7.70 feet to a point, and

S 06° 25' 46" W, a distance of 64.78 feet to the southeasterly corner of the Lower Locks Gatehouse; thence along the southerly face of the gatehouse

N 83° 34' 14" W, a distance of 7.50 feet to the point of beginning.

Containing 838 square feet of land, more or less.

PARCEL III:

The land, with any buildings and fixtures thereon, located on the Pawtucket Canal in Lowell, Middlesex County, Massachusetts, commonly known as the Lower Locks Chambers, and more particularly bounded and described as follows:

Beginning at the most westerly corner of the parcel, said corner being a point on the northerly line of Parcel CB-H, as shown on the Plan hereinafter described, and bearing S 85° 57' 30" E, and being 49.55 feet distant from a drill hole set in the southwesterly end of a concrete wall; thence running to a point on the northerly side of the Lower Locks

N 12° 49' 10" E, a distance of 23.64 feet; thence running along the outer edge of the granite blocks

S 82° 56' 24" E, a distance of 17.44 feet to a point on the southerly prolongation of the westerly line of the Lower Locks Gatehouse; thence

N 06° 25' 46" E, a distance of 1.49 feet to the southwesterly corner of the Lower Locks Gatehouse; thence along the southerly face of said Gatehouse

S 83° 34' 14" E, a distance of 7.50 feet to the southeast corner of the Lower Locks Gatehouse; thence along the easterly wall of said Gatehouse

N 06° 25' 46" E, a distance of 4.76 feet to a point; thence along the northerly edge of the concrete capped wall of the Lower Locks

S 83° 18' 52" E, a distance of 126.25 feet to a point; thence along the northerly top edge of granite of the Lower Locks by three courses as follows:

N 89° 40' 25" E, a distance of 9.86 feet to a point,

S 82° 53' 58" E, a distance of 98.75 feet to a point, and

N 80° 11' 21" E, a distance of 11.35 feet to a point at the base of the granite blocks of the Lower Locks; thence running along the base of said blocks

S 06° 01' 39" W, a distance of 38.00 feet to an iron pin set at the base of the last granite stone on the southeasterly end of the Lower Locks, said iron pin being at an angle in the northerly line of Parcel CB-H as hereinbefore mentioned; thence running along the southerly line of the Lower Locks, being the northerly line of Parcel CB-H, by four courses as follows:

N 83° 10' 03" W, a distance of 136.39 feet to a drill hole set in granite,

N 83° 28' 56" W, a distance of 110.00 feet to an iron pin set,

N 44° 46' 55" W, a distance of 8.86 feet to an x-cut set in granite, and

N 85° 57' 30" W, a distance of 20.24 feet to the point of beginning.

Containing 9,127 square feet of land, more or less.

All three parcels are shown on sheet 14 of a set of plans entitled "Lowell Canal System, Lowell Heritage State Park, Lowell, Massachusetts" prepared by Atlantic Engineering and Survey Consultants, dated 1 July 1983 and recorded with the Middlesex Northern District Registry of Deeds at Plan Book 157, Plan 69.

All three parcels are a portion of the premises taken by the Commonwealth of Massachusetts by Order of Taking dated December 1, 1986 and recorded with said Registry of Deeds at Book 3830, Page 70.

Appendix E – GIS Database Exported Maps

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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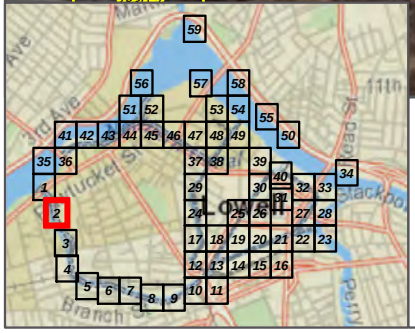
FEET

DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

DISCLAIMER:



Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

DISCLAIMER:


4550-490
3790-43
3790-41
Parcel: Hydraulic Gate House - See Fig# 0004
Researched Owner: Commonwealth(CW) owns in fee buildings, structures and fixtures above 88.2ft. MSL except structures/ equipment used for hydropower generation. Proprietors owns all structures and fixtures below 88.2ft. MSL.
Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 88.2ft. MSL.Boott has easement for the right to access,operate and maintain.NPS holds easement for access, construction,maintenance of improvements.
Parcel: 8-B - See Fig# 0002; 0003; 0004
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.
5285-33
0795-725
0795-719.1
Parcel: Francis Gatehouse - See Fig# 0004
Researched Owner: Commonwealth(CW) owns in fee buildings, structures and fixtures above 106.2ft. MSL except structures/equipment used for hydropower generation. Proprietor owns all structures and fixtures below 106.2ft. MSL.
Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 106.2ft. MSL.Boott has easement for the right to access,operate and maintain.
NPS holds easement for access,construction, maintenance of improvements.
Pawtucket Canal
0795-711
MADONNA CIRCLE
Parcel: 8-C - See Fig# 0004
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.
5615-76
0795-733
0795-719
Parcel: Locking Gate House - See Fig# 0004
Researched Owner: Commonwealth(CW) owns in fee buildings, structures and fixtures above 99.2ft. MSL except structures/equipment used for hydropower generation. Proprietors owns all structures and fixtures below 99.2ft. MSL.
Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 99.2ft. MSL.Boott has easement for the right to access,operate and maintain.
NPS holds easement for access,construction, maintenance of improvements.
0795-713
4550-484
5285-9
0795-735
Parcel: 8-A, Lot 1 - See Fig# 0004
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.
5285-5
0795-741
WAY-STREET
0795-743
Parcel: Guards Locks - Lock Chamber
See Fig# 0004
Researched Owner: Proprietors owns the Guard Locks Lock Chambers.
Researched Easement: CW has permanent and exclusive easement for supplemental maintenance, preservation, conservation, landscaping and erection of structures. Boott has an easement for the right to access, operate and maintain. NPS holds an easement for access, construction and maintenance of improvements, as well as to run boat tours.
0795-751
0795-700
0795-736
0795-726
0795-722
0795-706
Lowell Land Resources Map
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Land Resource Parcel / Exhibit
City Of Lowell Real Propery Data
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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY
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Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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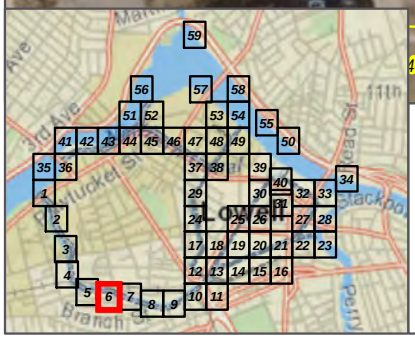

Lowell Land Resources Map

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- Land Resource Parcel / Exhibit
- City Of Lowell Real Propery Data

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Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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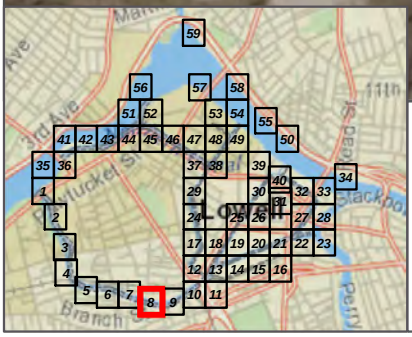

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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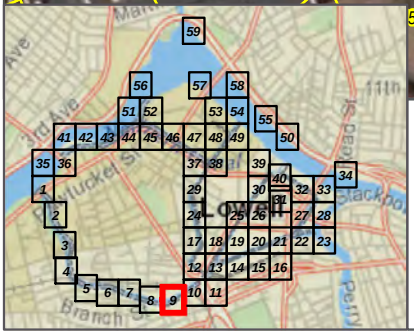

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

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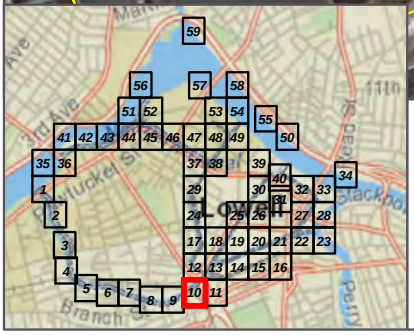

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

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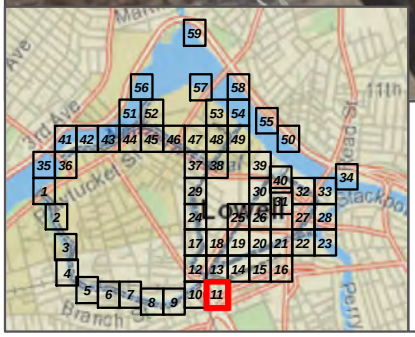

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

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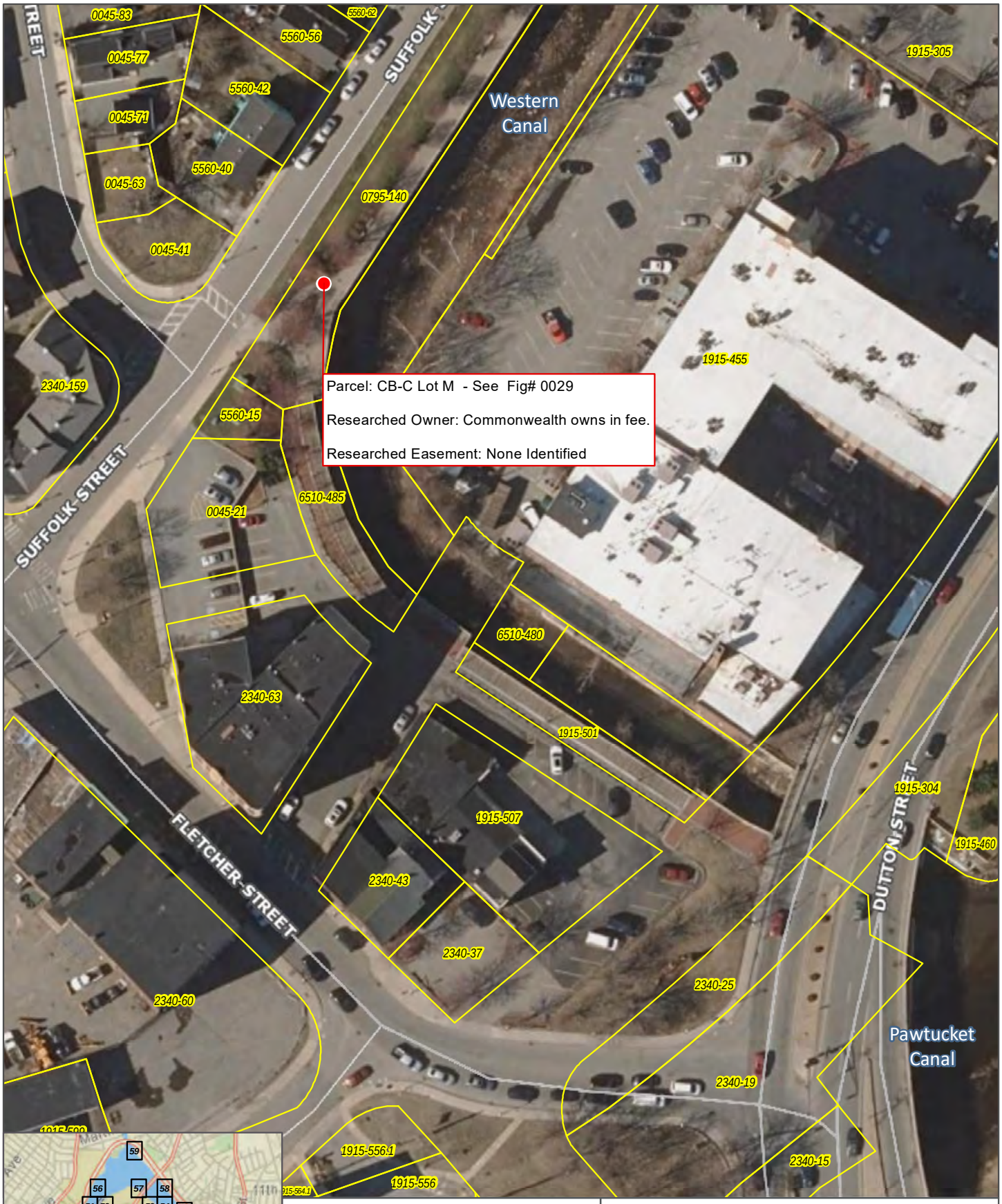

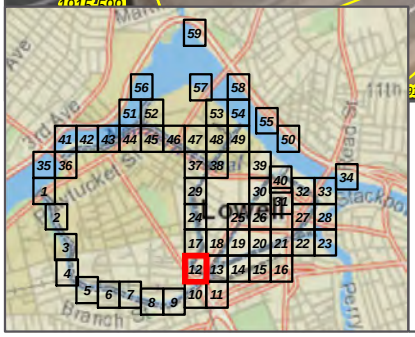

Lowell Land Resources Map

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Land Resource Parcel / Exhibit

City Of Lowell Real Propery Data

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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY

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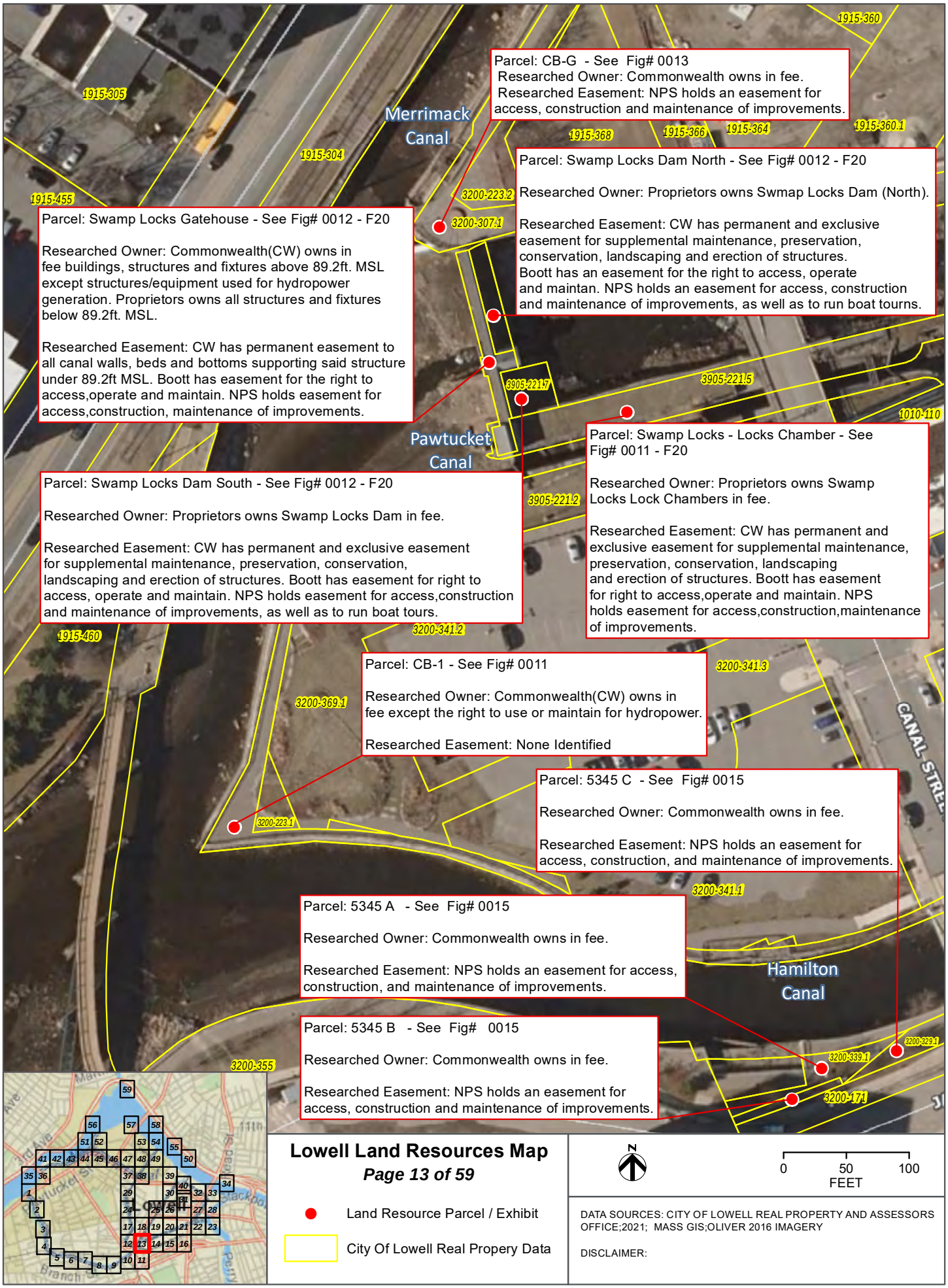
Parcel: CB-G - See Fig# 0013
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.
Merrimack Canal
Parcel: Swamp Locks Dam North - See Fig# 0012 - F20
Researched Owner: Proprietors owns Swmap Locks Dam (North).
Researched Easement: CW has permanent and exclusive easement for supplemental maintenance, preservation, conservation, landscaping and erection of structures. Boott has an easement for the right to access, operate and maintan. NPS holds an easement for access, construction and maintenance of improvements, as well as to run boat tourns.
Parcel: Swamp Locks Gatehouse - See Fig# 0012 - F20
Researched Owner: Commonwealth(CW) owns in fee buildings, structures and fixtures above 89.2ft. MSL except structures/equipment used for hydropower generation. Proprietors owns all structures and fixtures below 89.2ft. MSL.
Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 89.2ft MSL. Boott has easement for the right to access,operate and maintain. NPS holds easement for access,construction, maintenance of improvements.
Pawtucket Canal
Parcel: Swamp Locks - Locks Chamber - See Fig# 0011 - F20
Researched Owner: Proprietors owns Swamp Locks Lock Chambers in fee.
Researched Easement: CW has permanent and exclusive easement for supplemental maintenance, preservation, conservation, landscaping and erection of structures. Boott has easement for right to access,operate and maintain. NPS holds easement for access,construction,maintenance of improvements.
Parcel: Swamp Locks Dam South - See Fig# 0012 - F20
Researched Owner: Proprietors owns Swamp Locks Dam in fee.
Researched Easement: CW has permanent and exclusive easement for supplemental maintenance, preservation, conservation, landscaping and erection of structures. Boott has easement for right to access, operate and maintain. NPS holds easement for access,construction and maintenance of improvements, as well as to run boat tours.
Parcel: CB-1 - See Fig# 0011
Researched Owner: Commonwealth(CW) owns in fee except the right to use or maintain for hydropower.
Researched Easement: None Identified
Parcel: 5345 C - See Fig# 0015
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction, and maintenance of improvements.
Parcel: 5345 A - See Fig# 0015
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction, and maintenance of improvements.
Hamilton Canal
Parcel: 5345 B - See Fig# 0015
Researched Owner: Commonwealth owns in fee.
Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.
1915-360
1915-305
1915-304
1915-455
1915-368
1915-366
1915-364
1915-360.1
3200-223.2
3200-307.1
3905-221.7
3905-221.5
1010-110
3905-221.2
1915-460
3200-341.2
3200-341.3
3200-369.1
3200-223.1
3200-341.1
3200-355
3200-329.1
3200-339.1
3200-171
CANAL STREET
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City Of Lowell Real Propery Data
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DATA SOURCES: CITY OF LOWELL REAL PROPERTY AND ASSESSORS OFFICE;2021; MASS GIS;OLIVER 2016 IMAGERY
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City Of Lowell Real Propery Data

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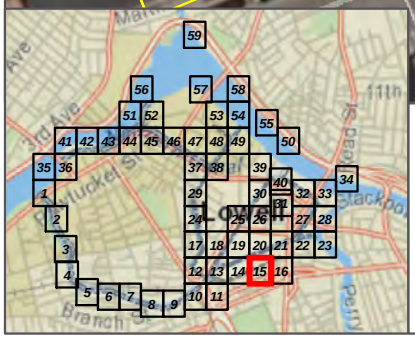

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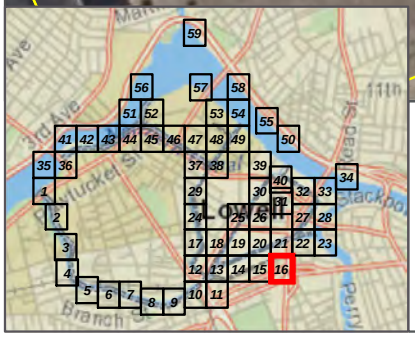

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City Of Lowell Real Propery Data

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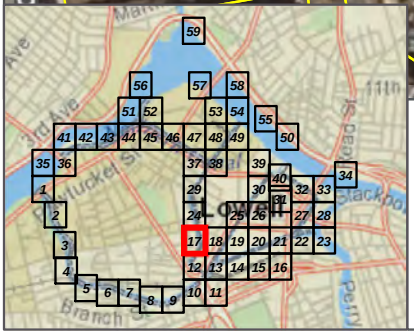

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City Of Lowell Real Propery Data

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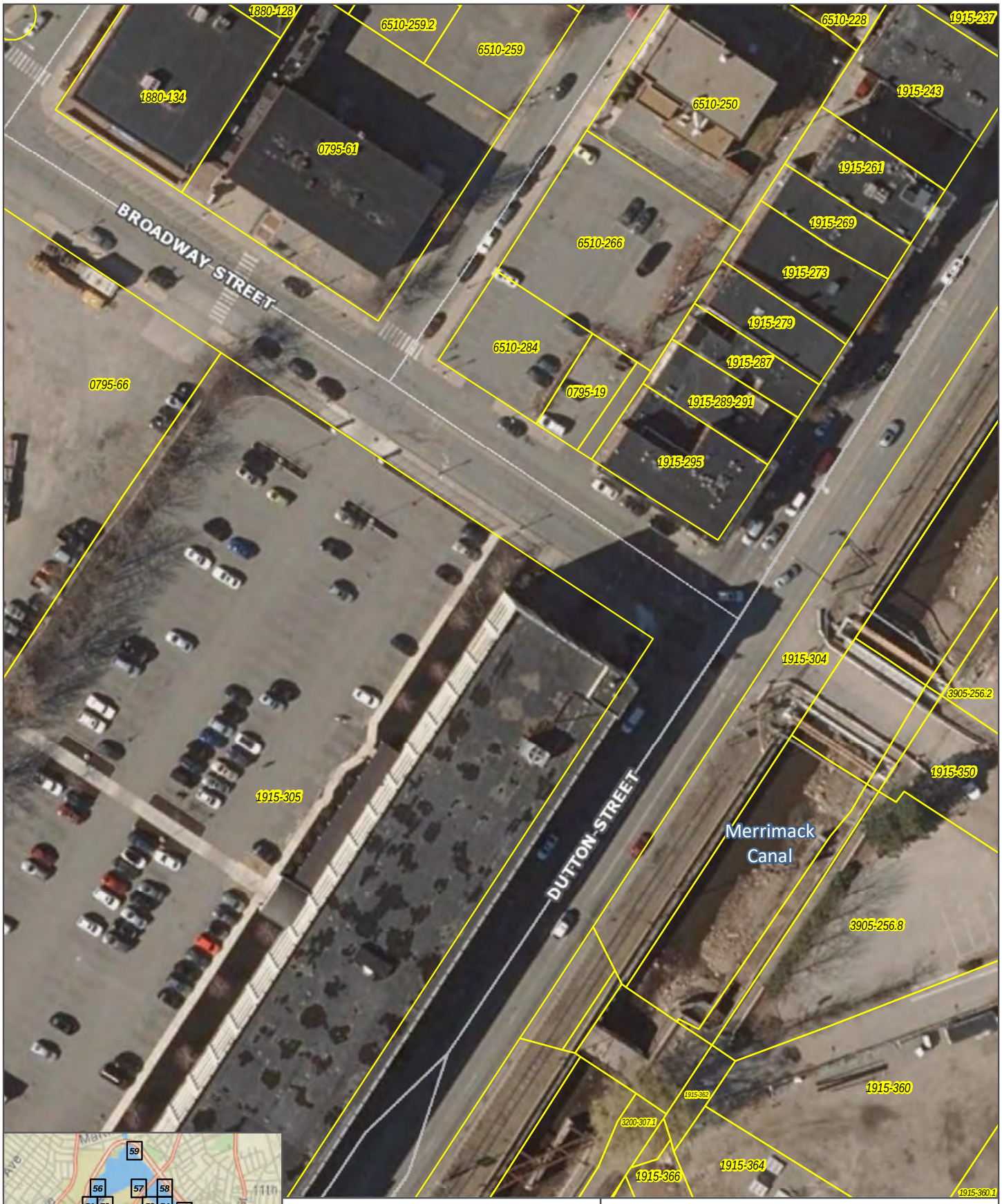

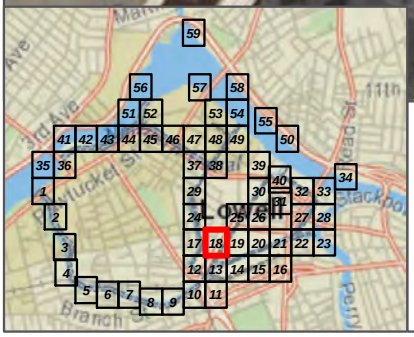

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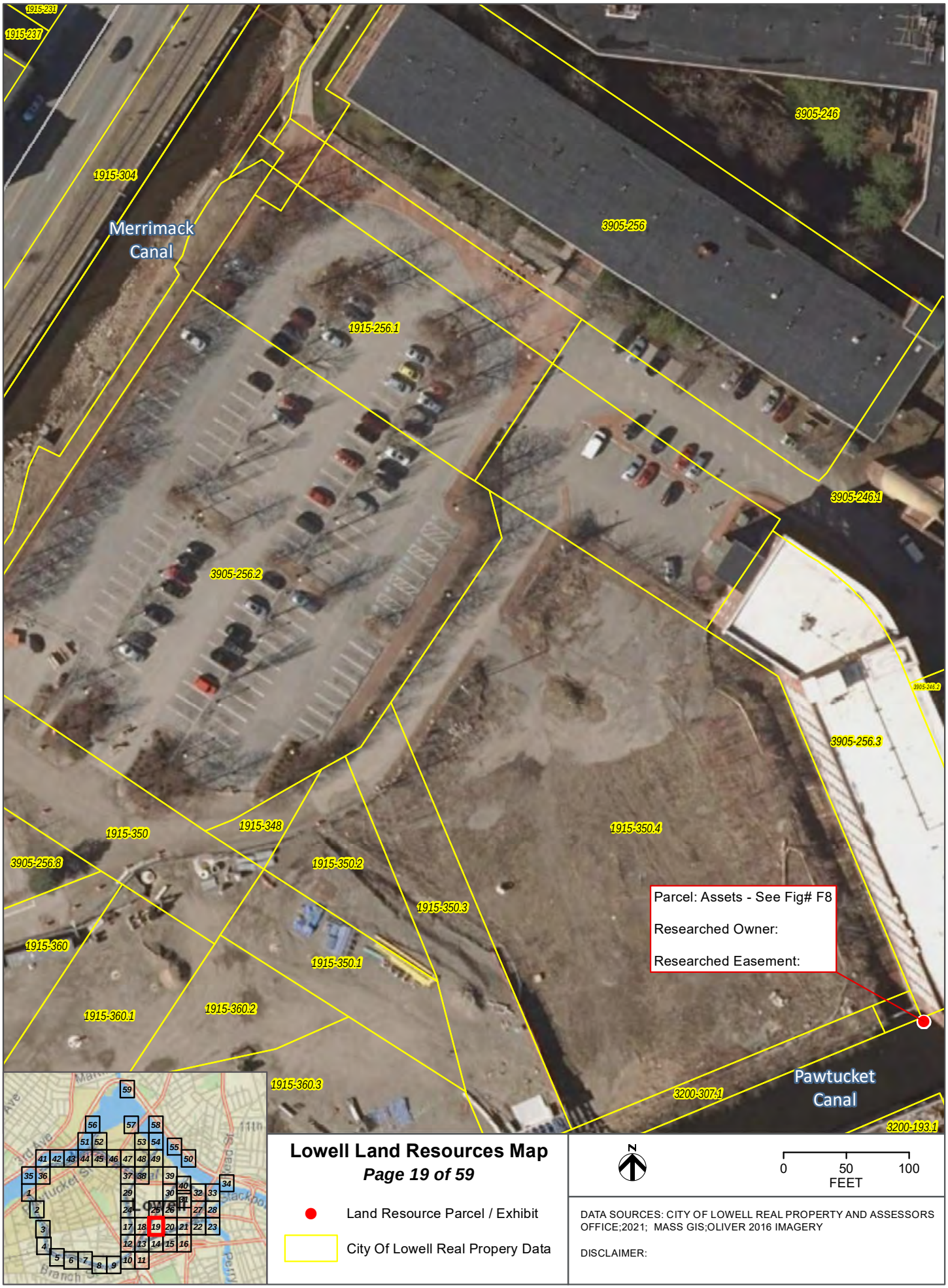

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City Of Lowell Real Propery Data

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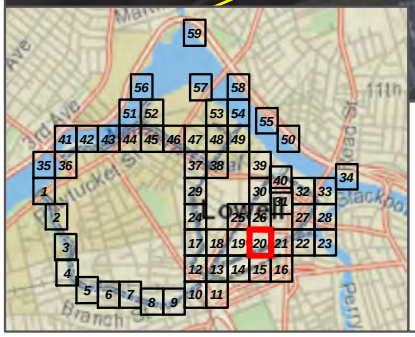

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City Of Lowell Real Propery Data

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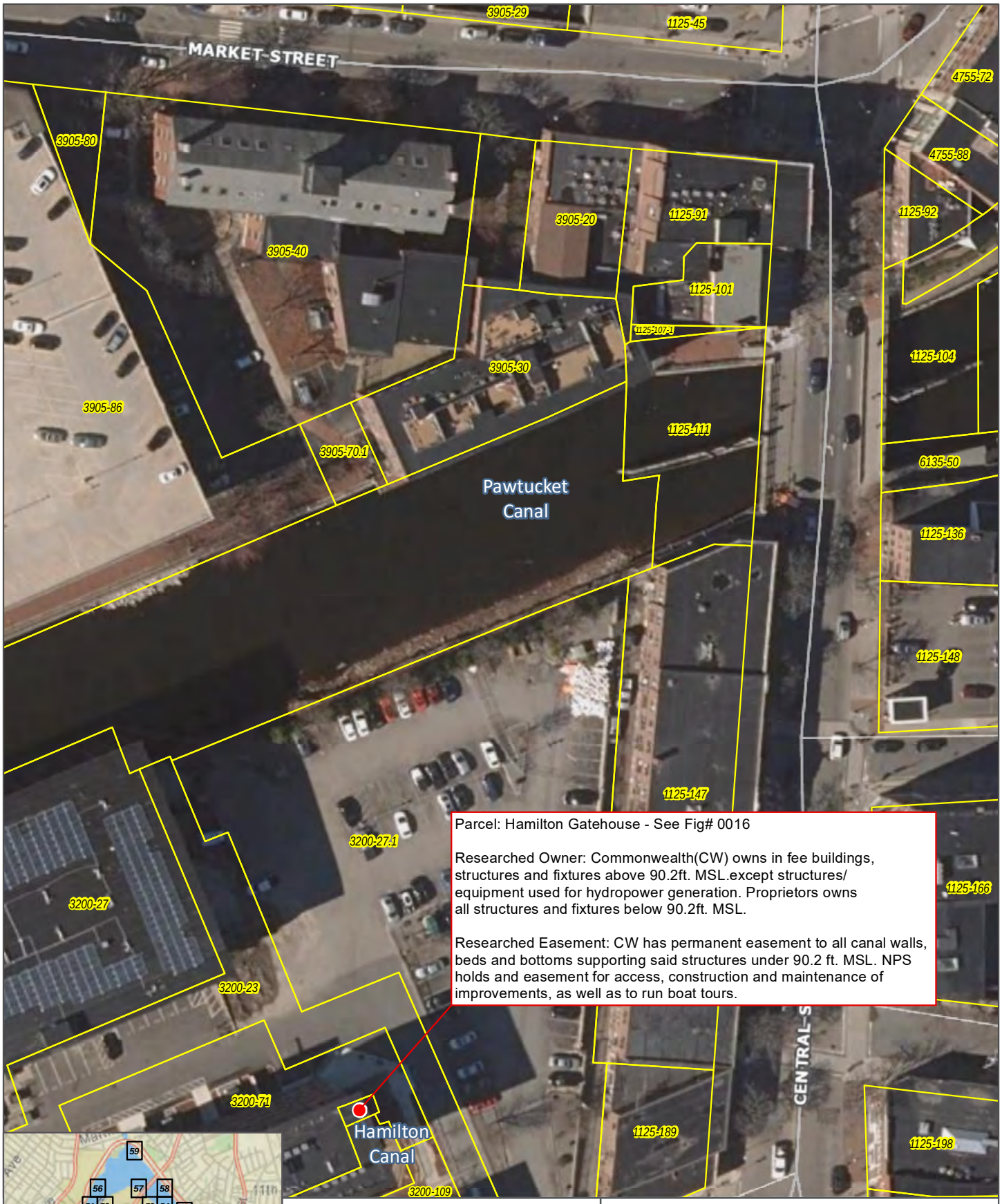
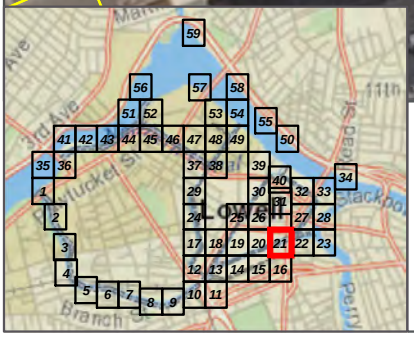


Parcel: Hamilton Gatehouse - See Fig# 0016

Researched Owner: Commonwealth(CW) owns in fee buildings, structures and fixtures above 90.2ft. MSL.except structures/ equipment used for hydropower generation. Proprietors owns all structures and fixtures below 90.2ft. MSL.

Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structures under 90.2 ft. MSL. NPS holds and easement for access, construction and maintenance of improvements, as well as to run boat tours.



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DISCLAIMER:

Parcel: Lower Locks Dam - See Fig# 0014

Researched Owner: Commonwealth(CW) owns in fee buildings structures and fixtures above 74.2ft. MSL except structures/equipment used for hydropower generation. Proprietors owns all structures and fixtures below 47.2ft. MSL.

Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 74.2ft. MSL. Boott has an easement for the right to access, operate and maintain. NPS holds an easement for access, construction and maintenance of improvments.

Parcel: Lower Locks Gatehouse - See Fig# 0014

Researched Owner: Commonwealth(CW) owns in fee buildings structures and fixtures above 74.2ft. MSL except structures/equipment used for hydropower generation. Proprietors owns all structures and fixtures below 74.2ft. MSL

Researched Easement: CW has permanent easement to all canal walls, beds and bottoms supporting said structure under 74.2ft. MSL. Boott has easement for the right to access,operate and maintain. NPS holds easement for access, construction and maintenance of improvements, as well as run boat tours.

Parcel: Lower Locks Lock Chamber - See Fig# 0014 - F20

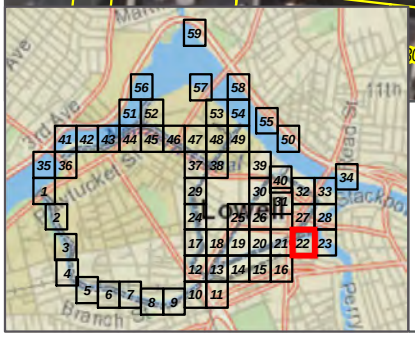
Researched Owner: Proprietors owns Lower Locks Lock Chamber.

Researched Easement: CW has permanent and exclusive easement for supplemental maintenance, preservation, conservation, landscaping and erection of structures. Boot has an easement for the right to access, operate and maintain. NPS holds an easement for access, construction and maintenance of improvements, as well as to run boat tours.

Parcel: CB-H - See Fig# 0014

Researched Owner: Commonwealth owns in fee.

Researched Easement: NPS holds an easement for access, construction and maintenance of improvements.



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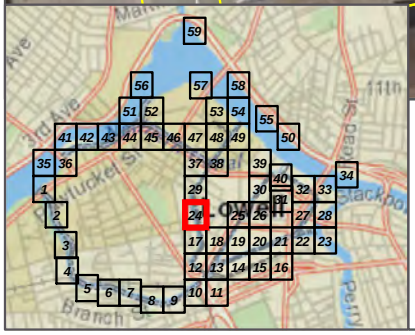

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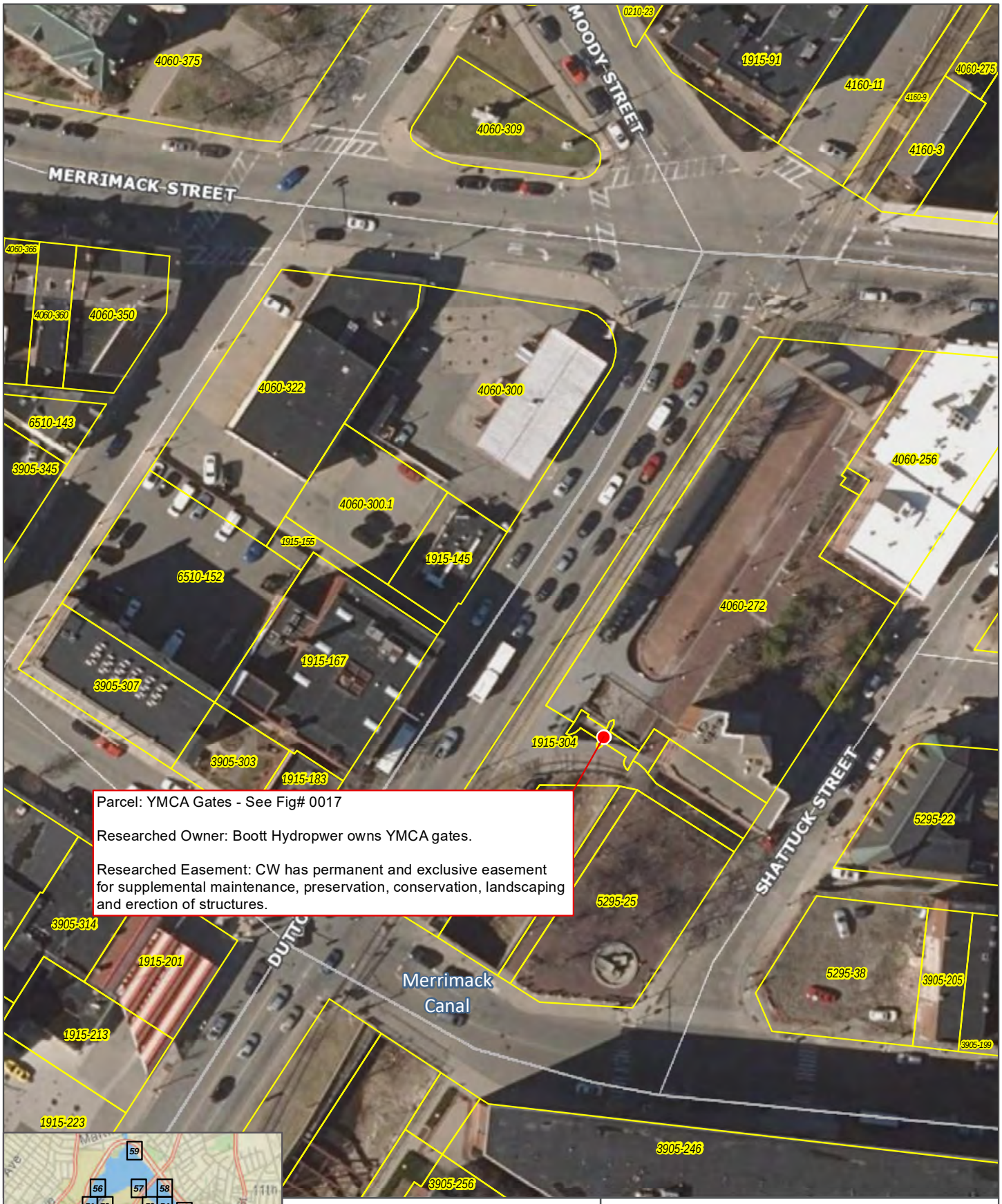

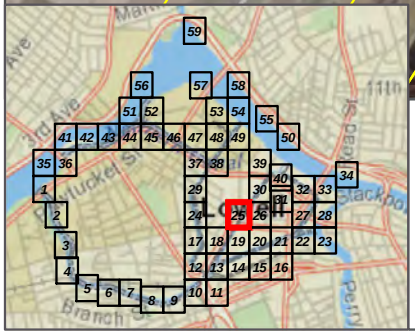

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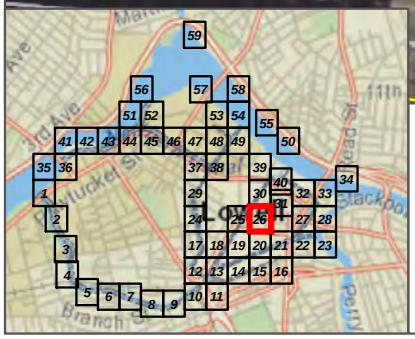

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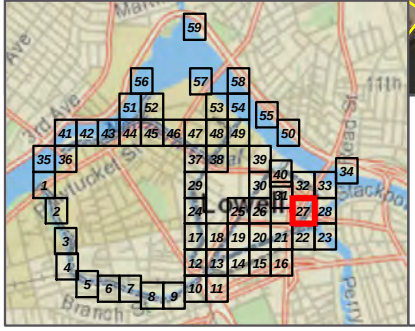

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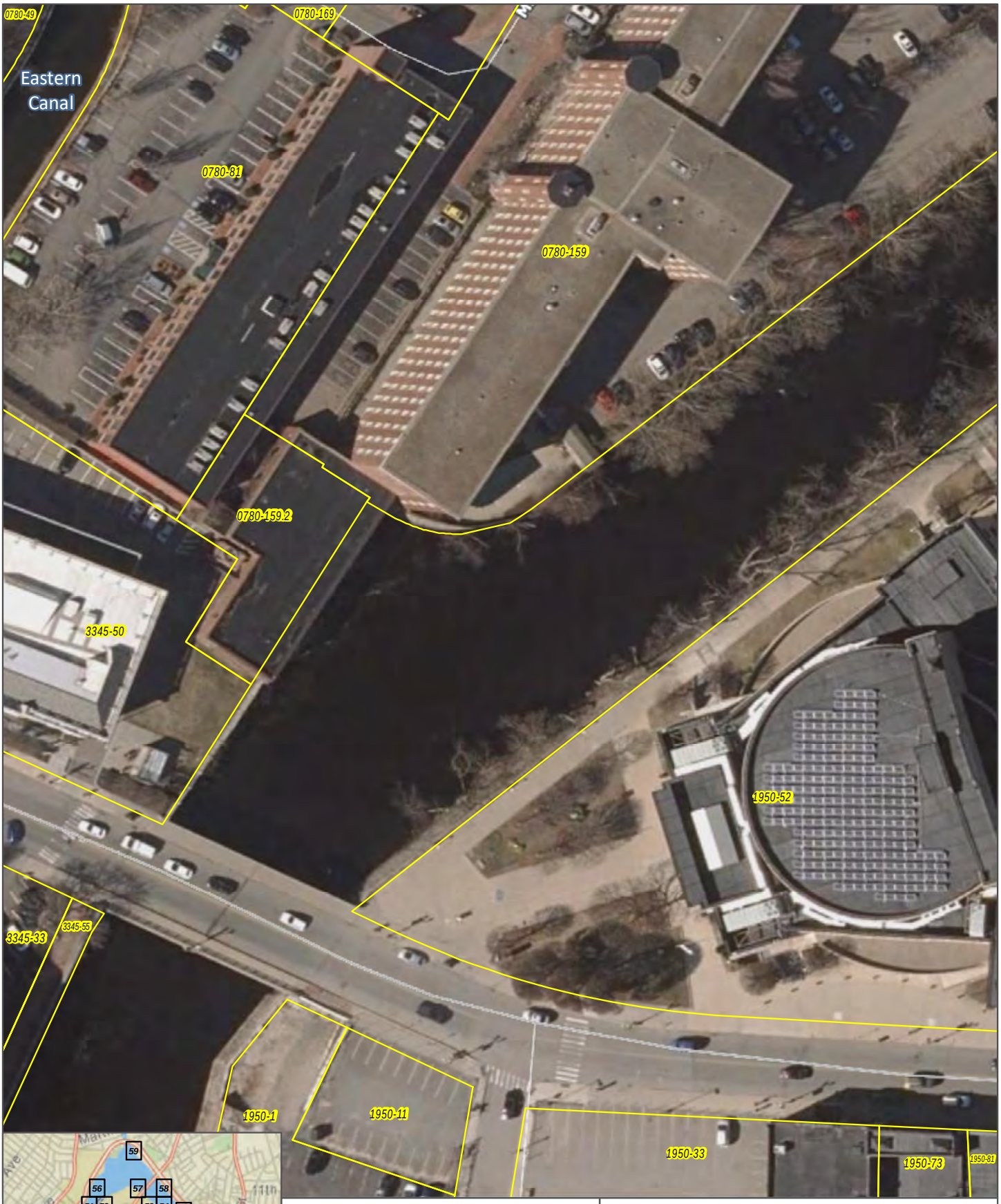

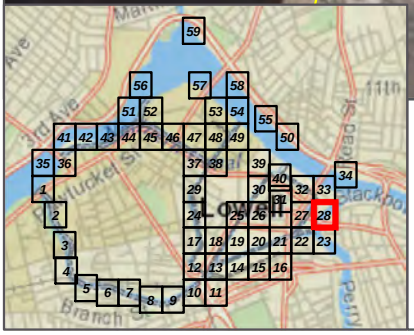

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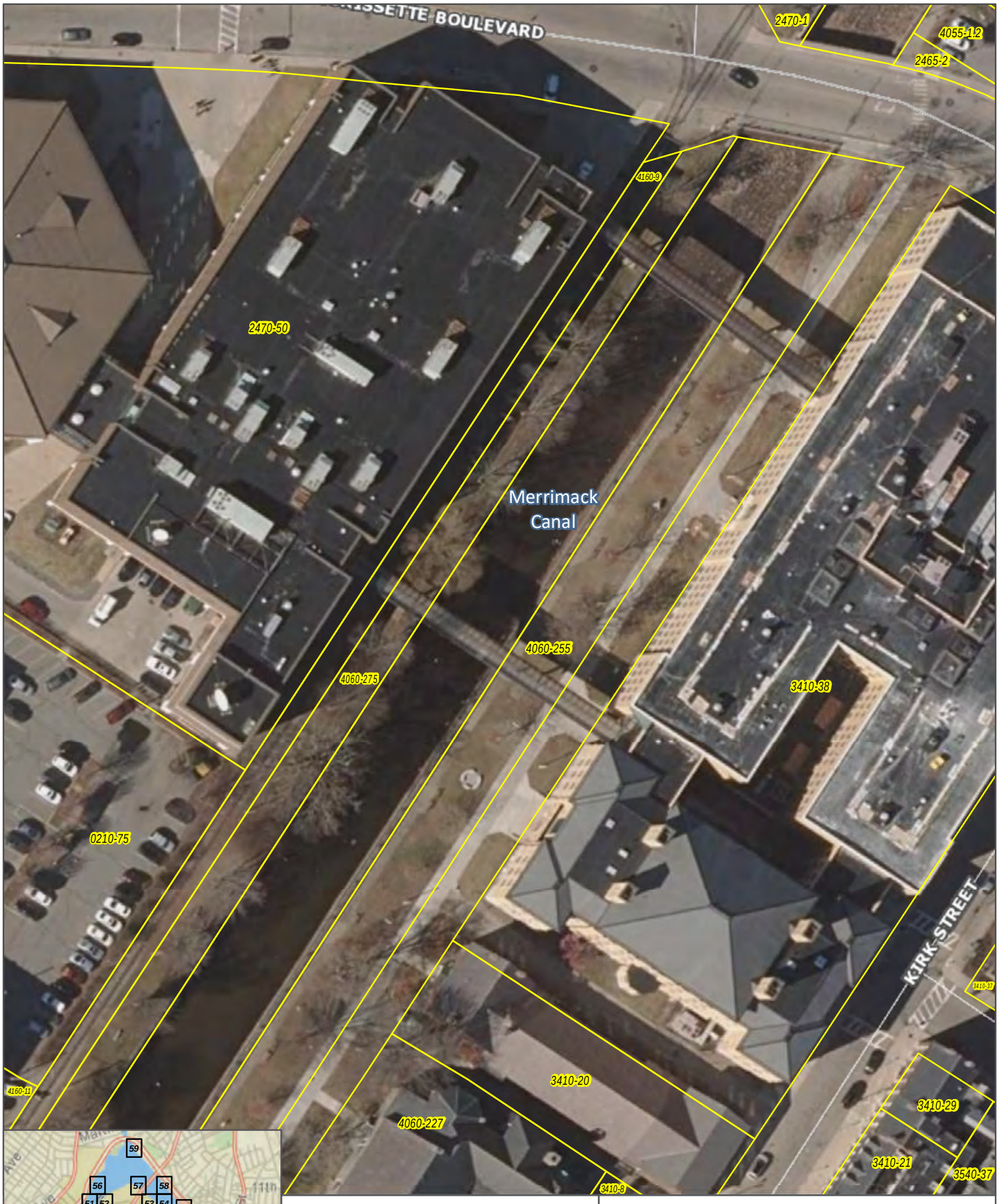

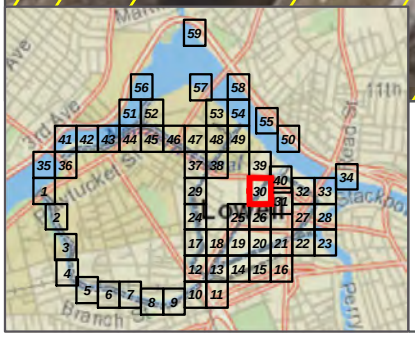

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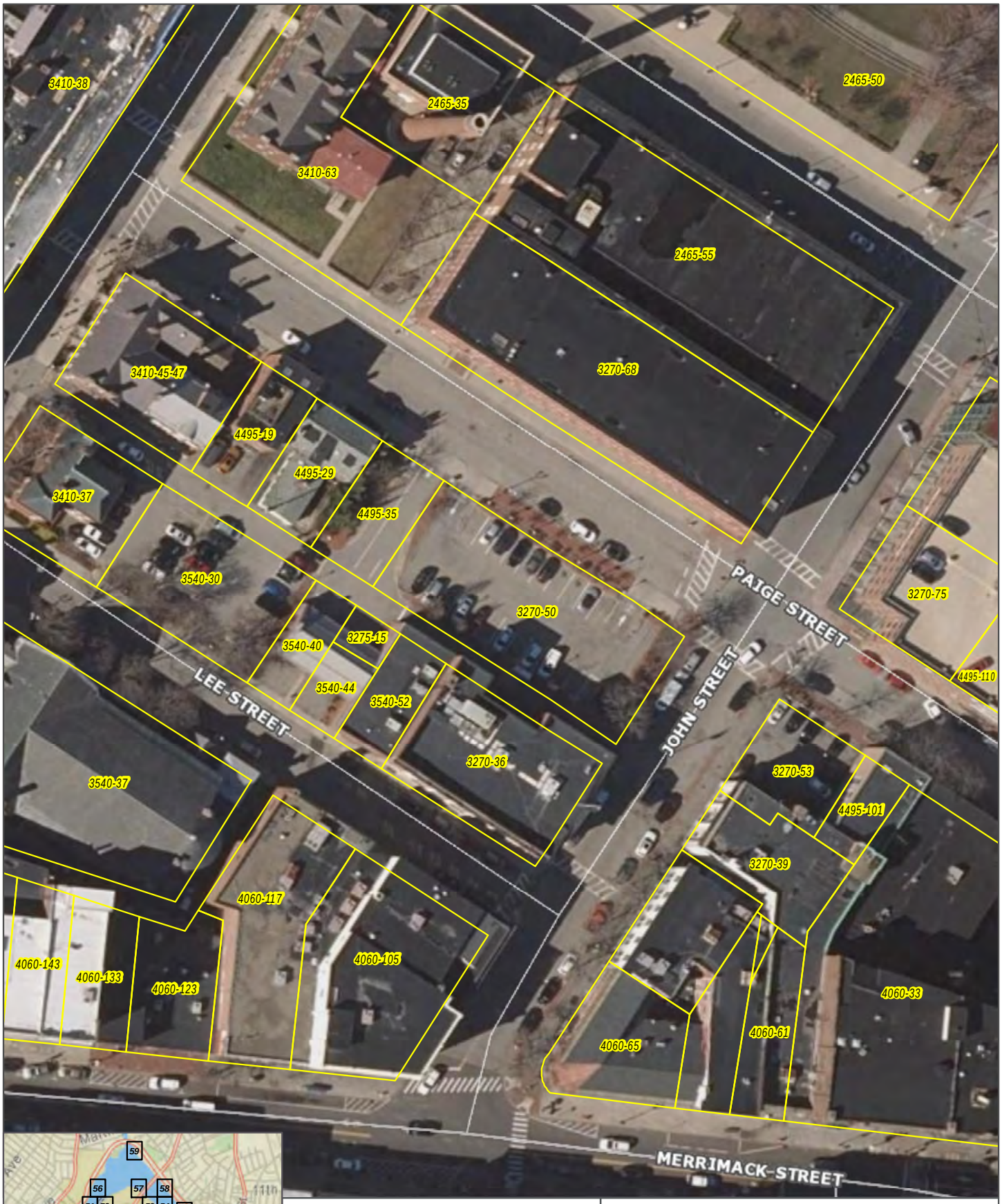

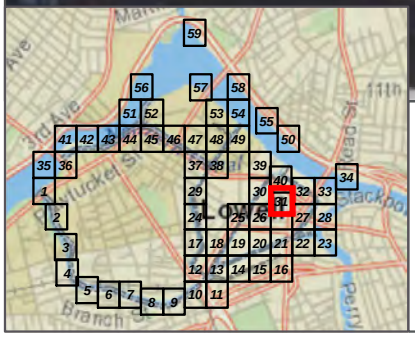

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City Of Lowell Real Propery Data

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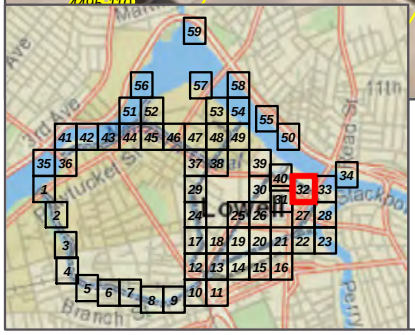

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City Of Lowell Real Propery Data

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City Of Lowell Real Propery Data

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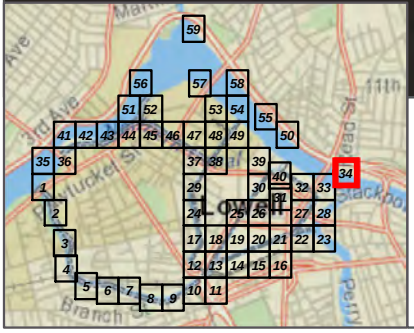

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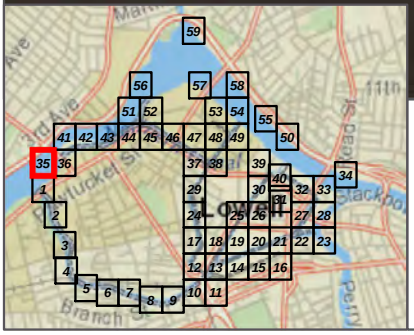

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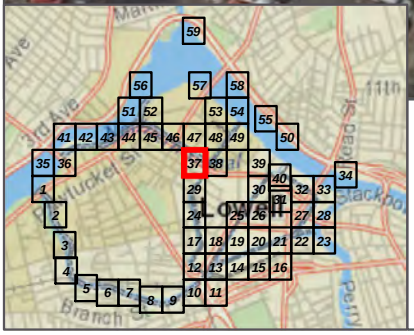

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City Of Lowell Real Propery Data

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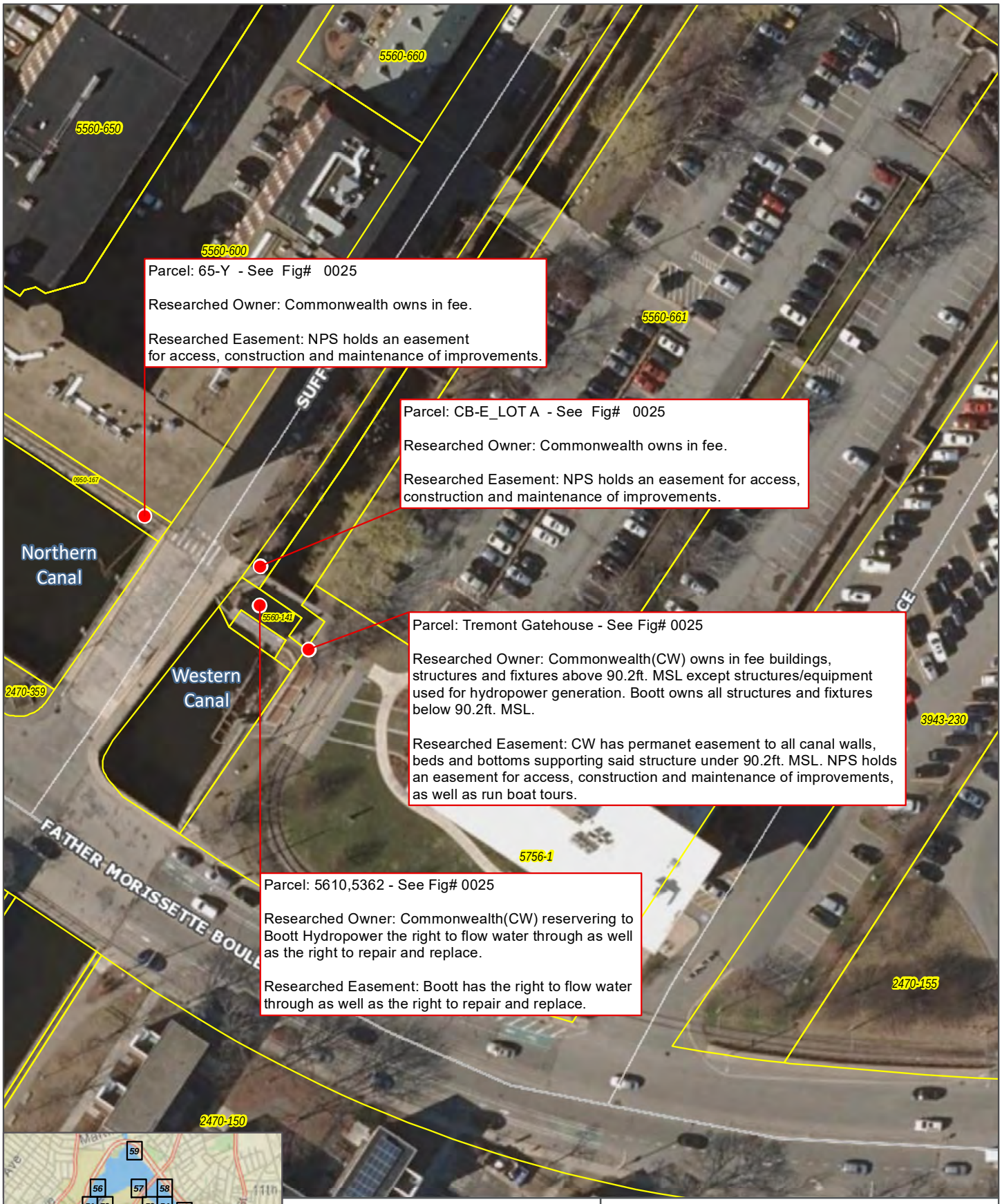

Lowell Land Resources Map

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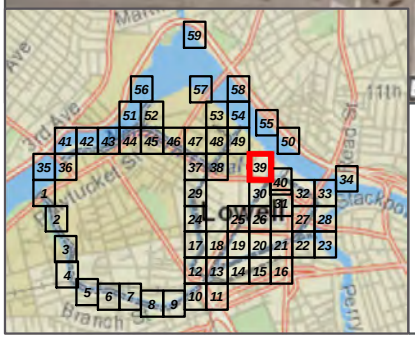

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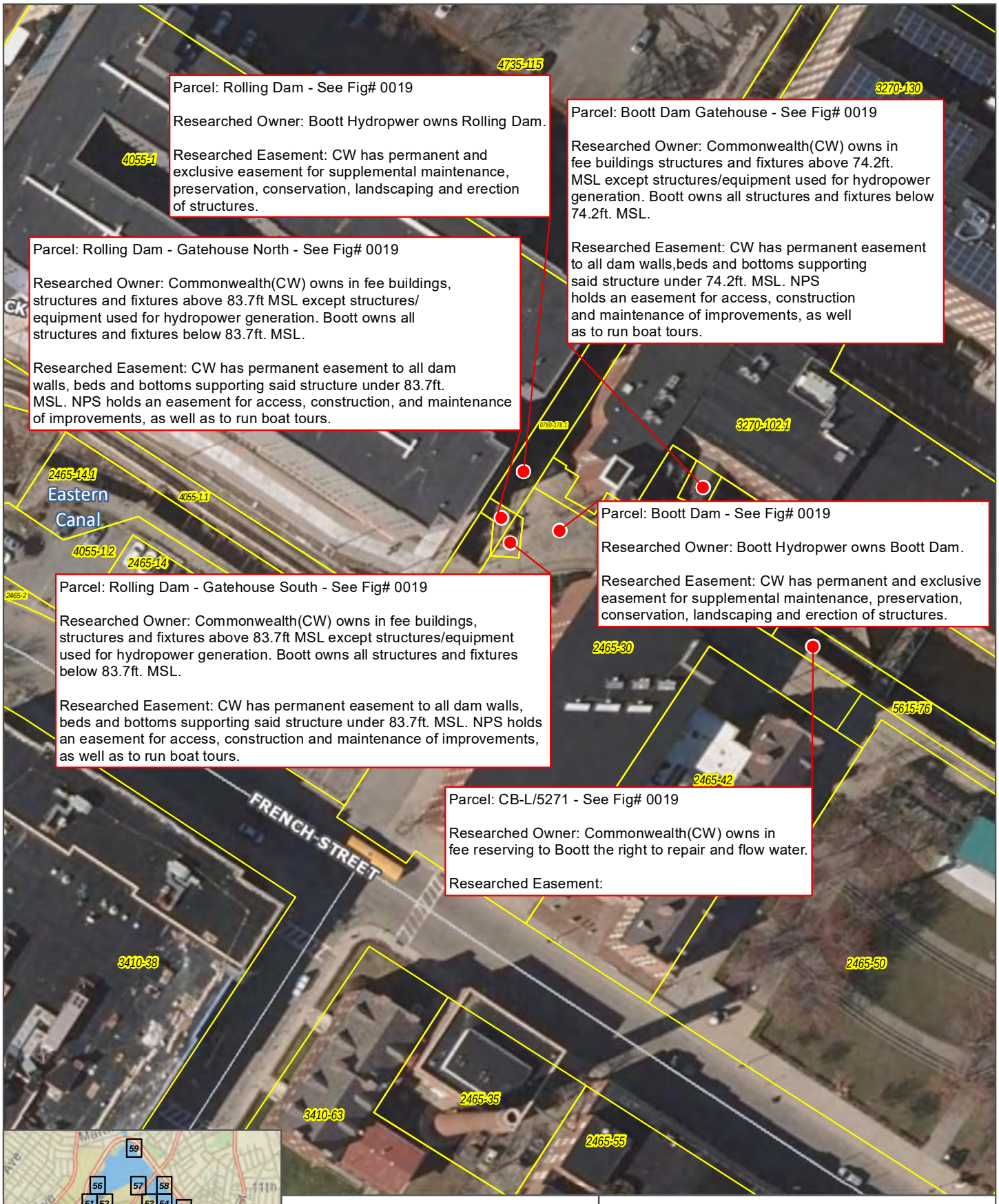

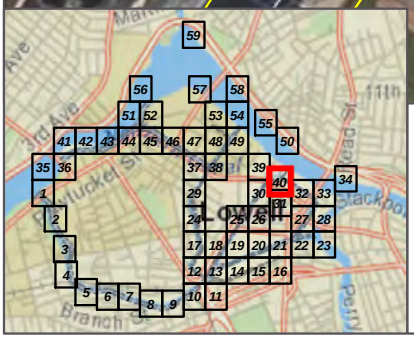

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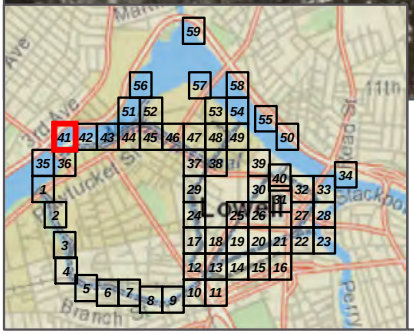

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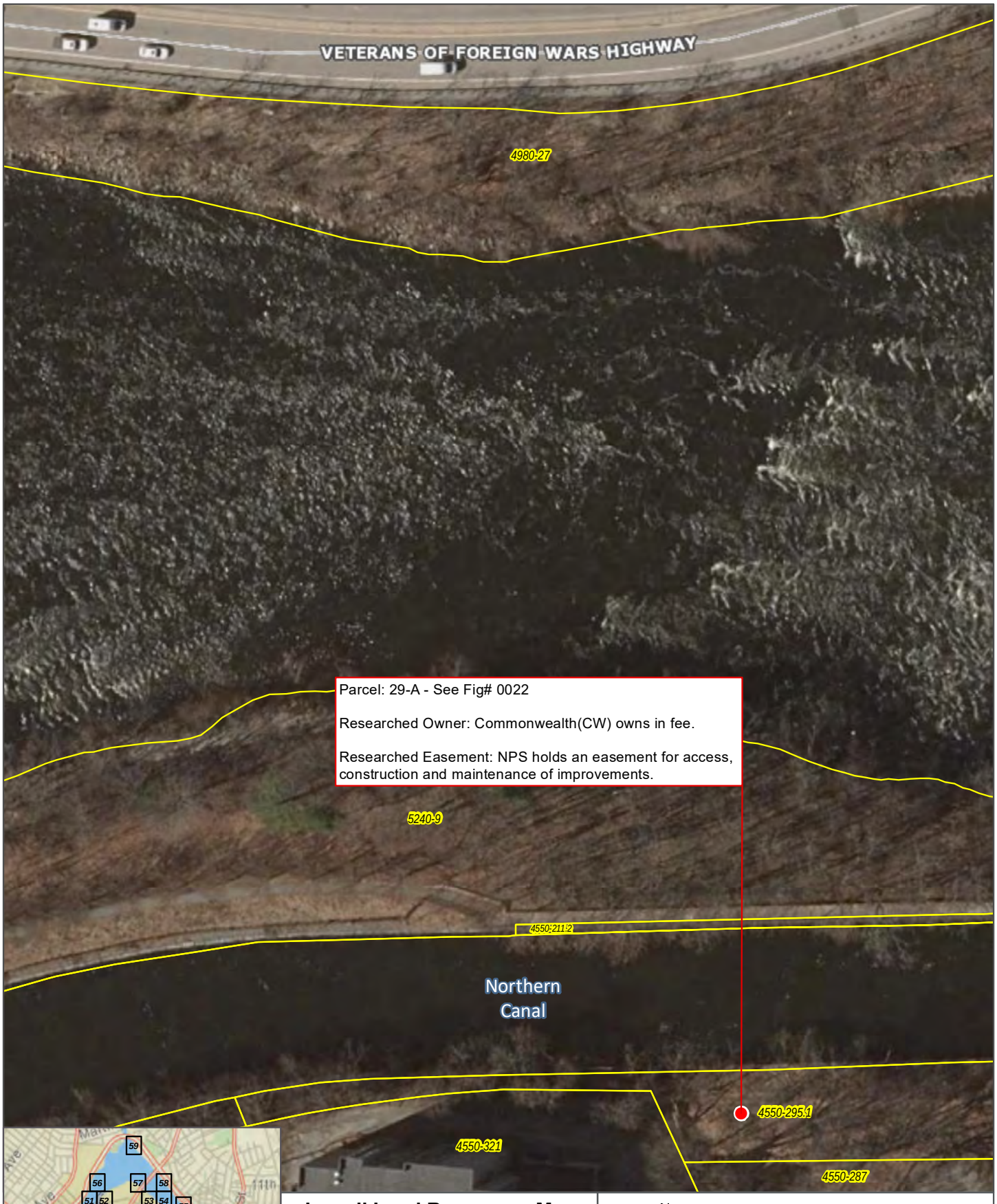

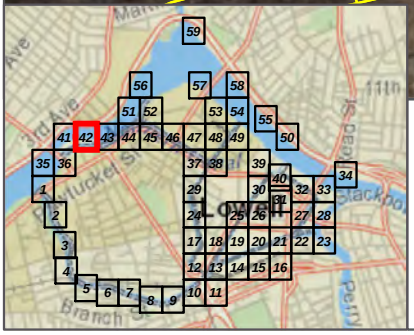

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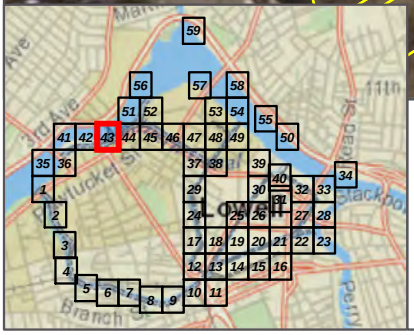

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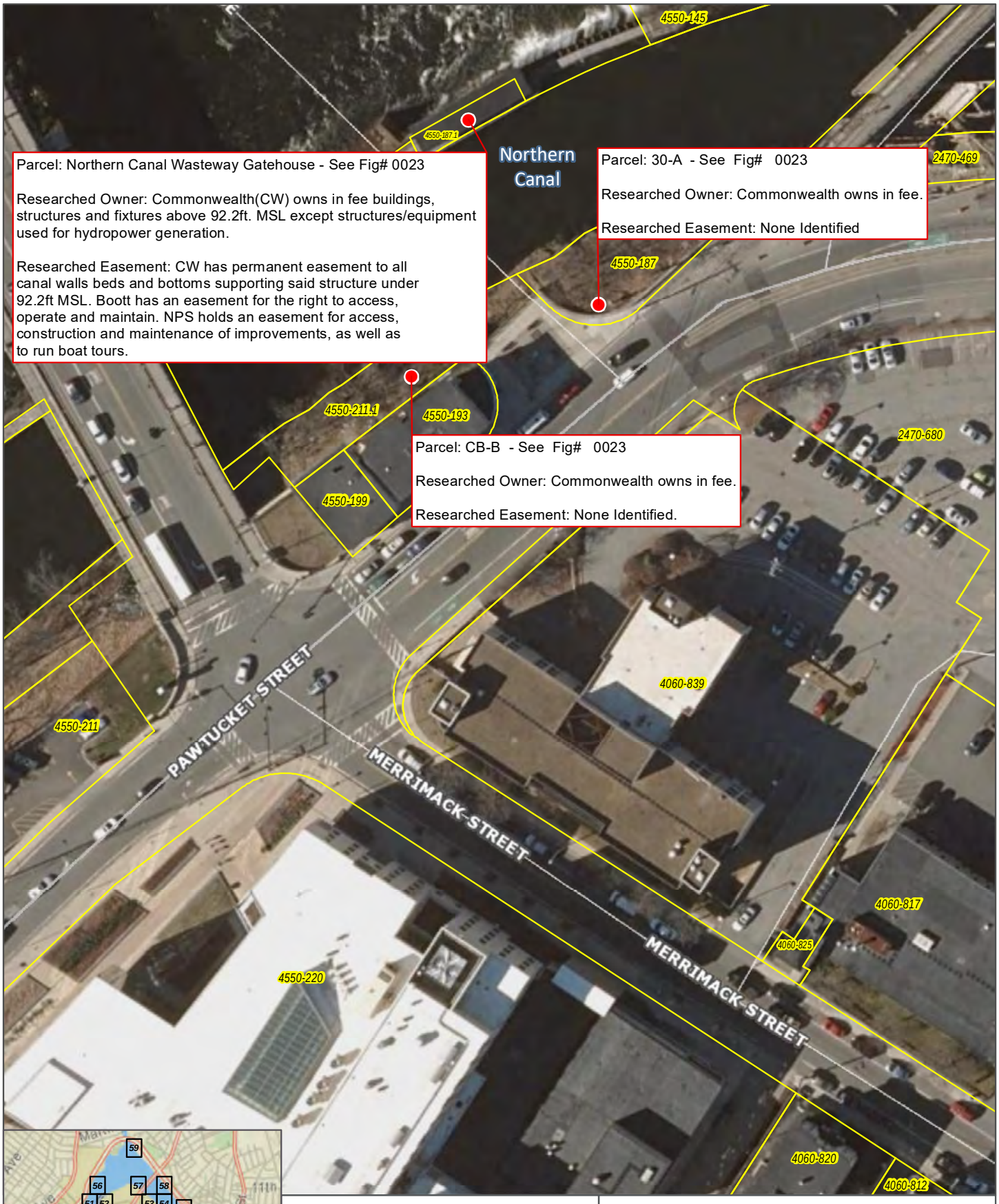

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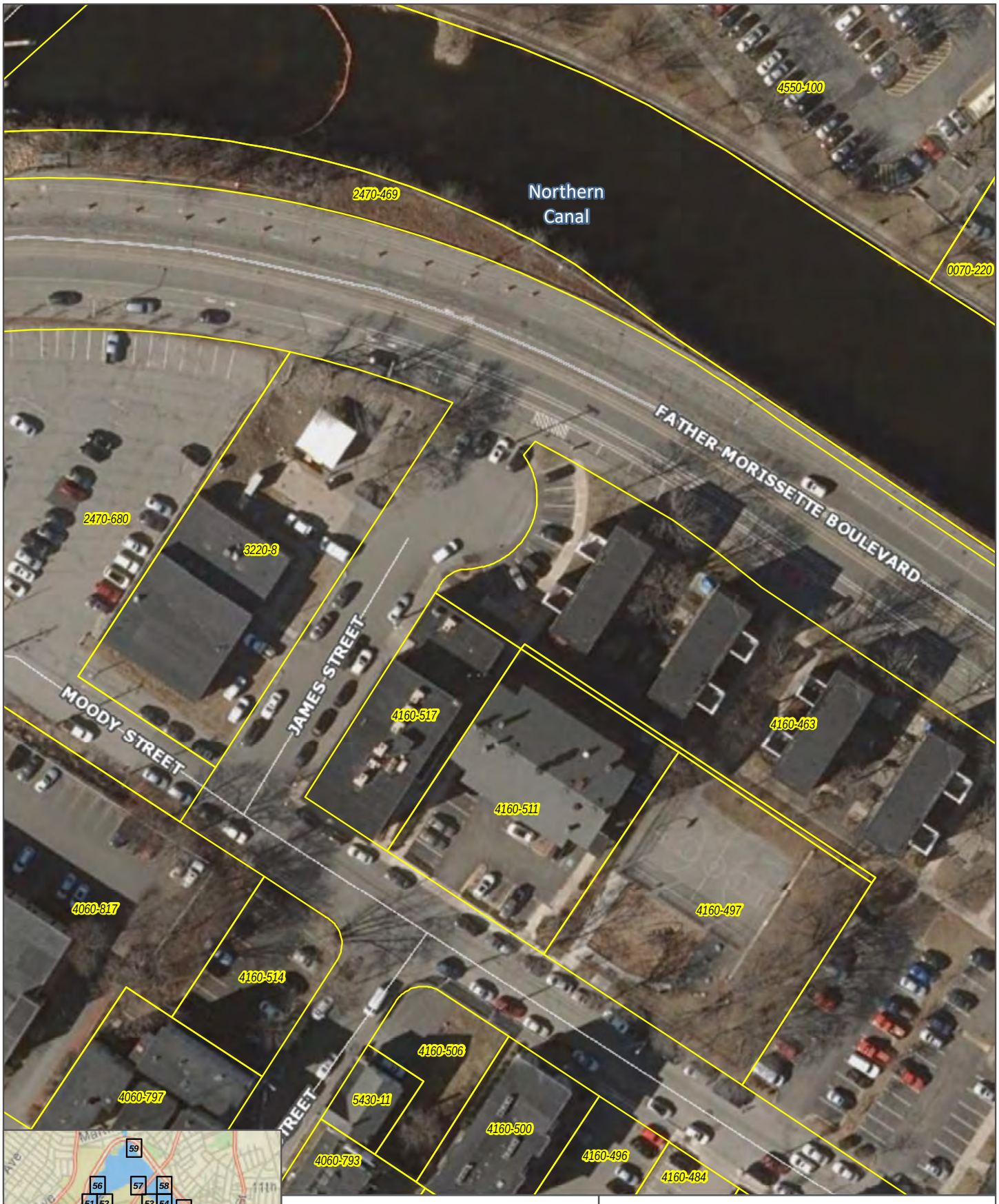

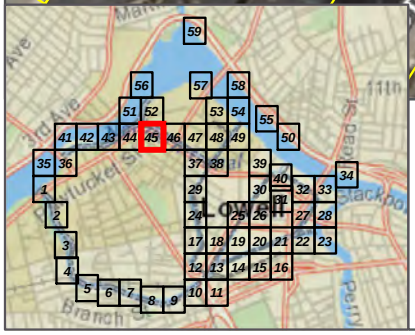

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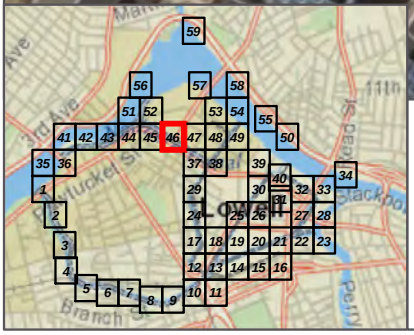

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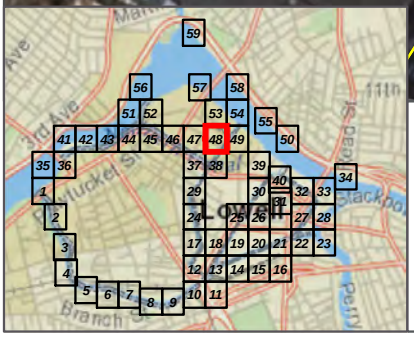

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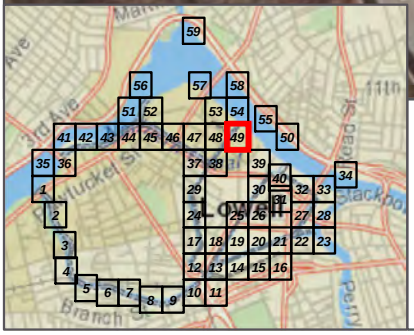

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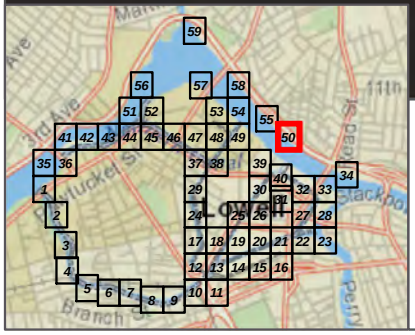

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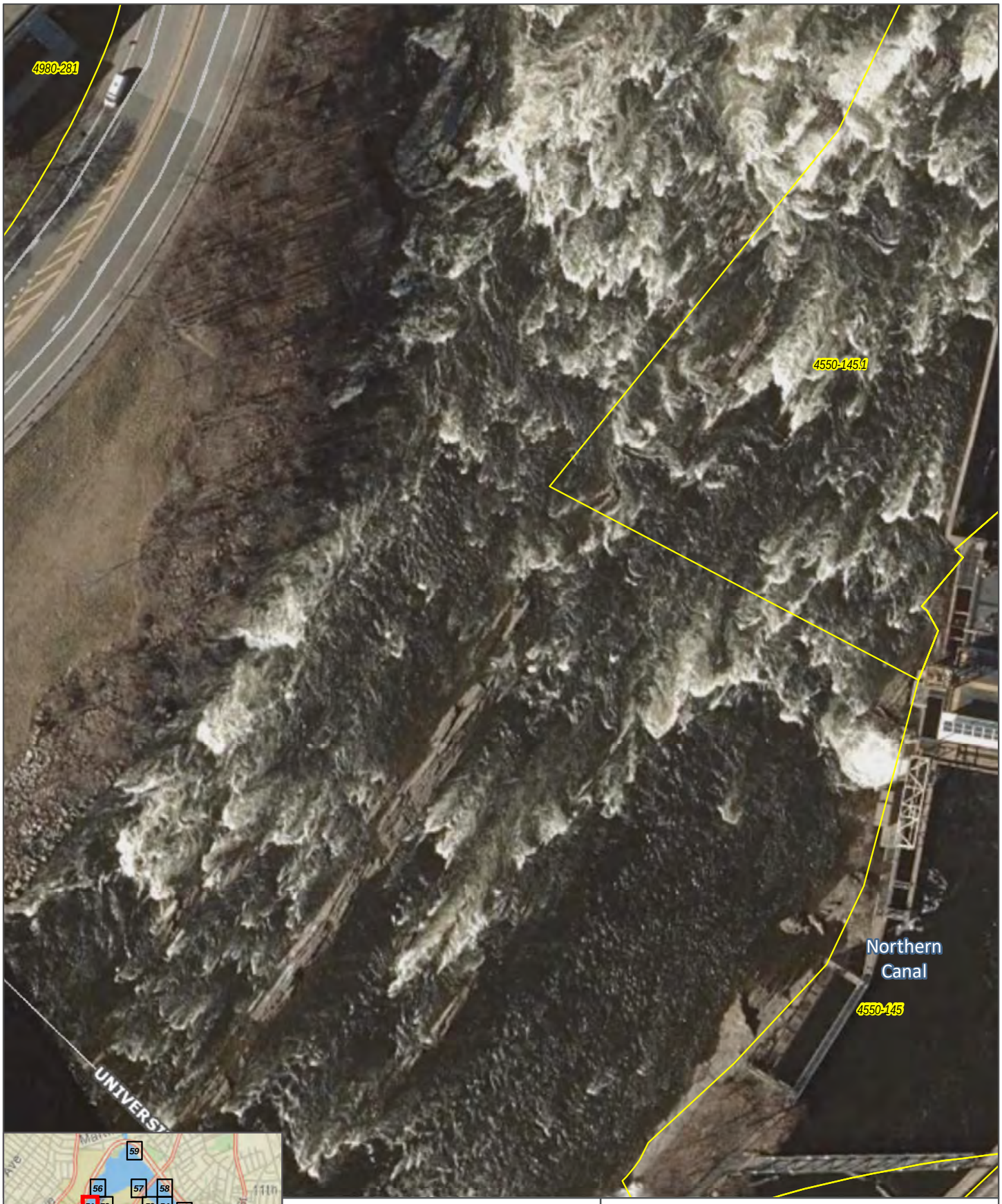

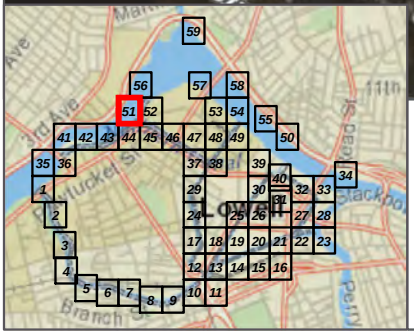

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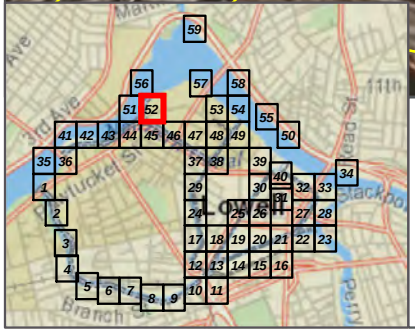

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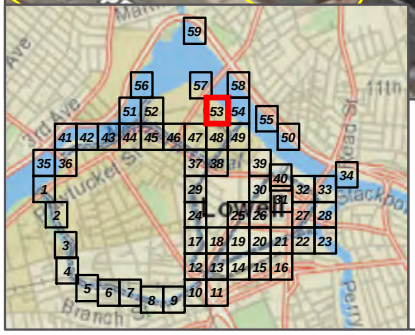

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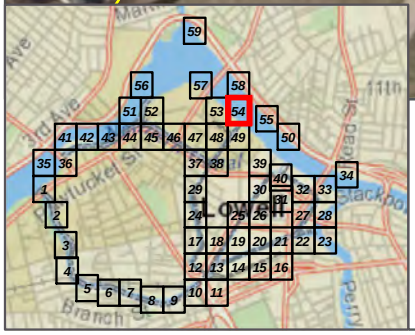

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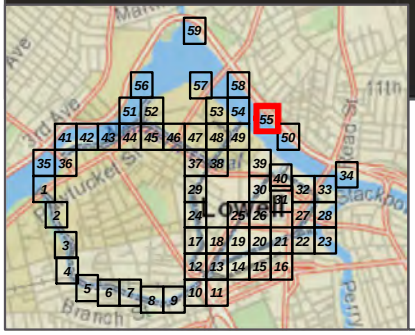

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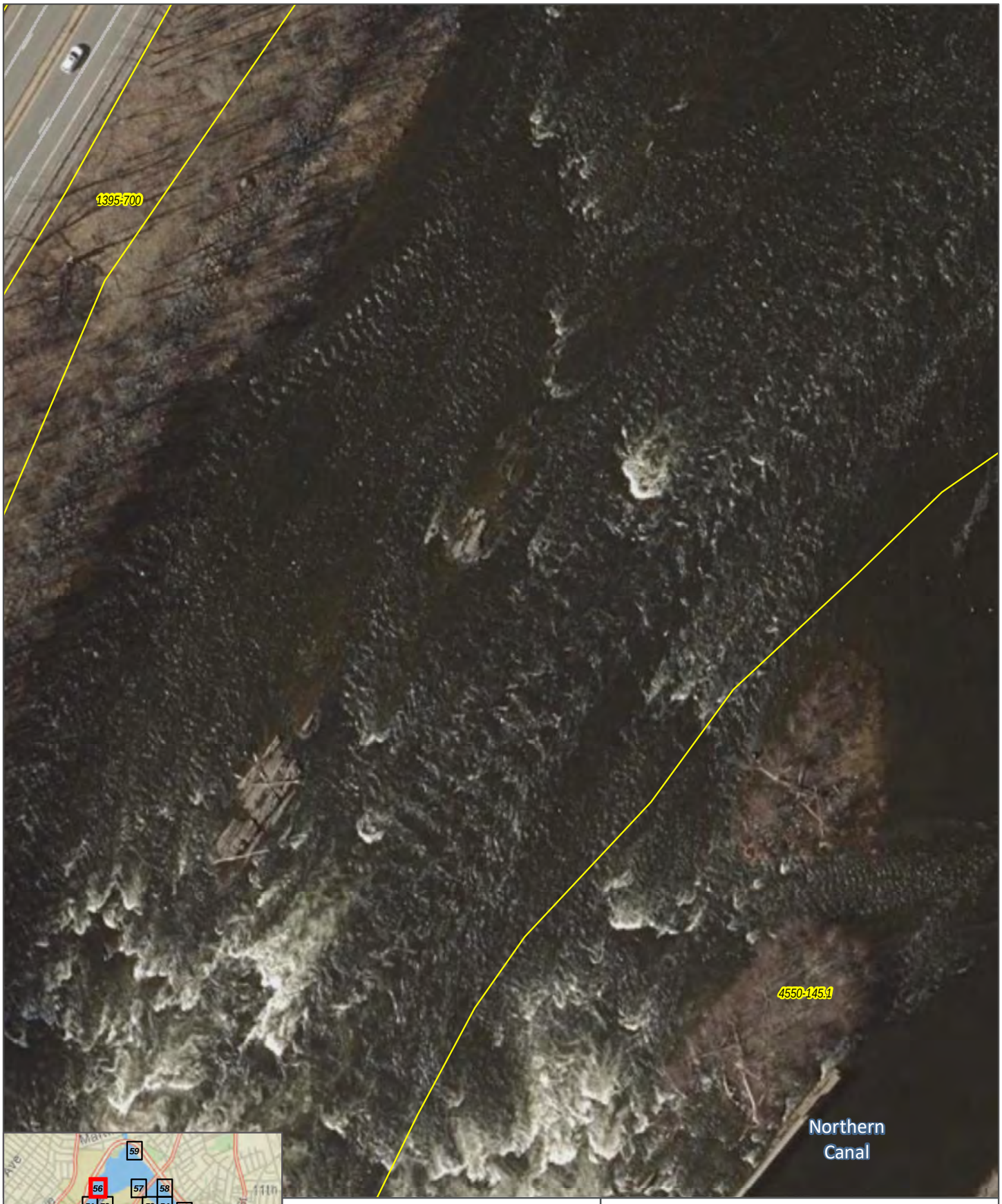

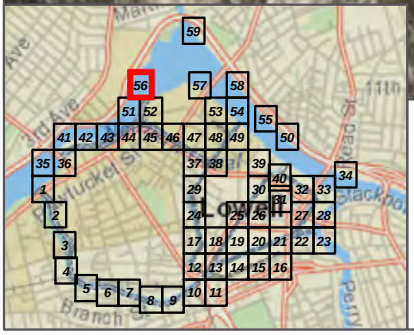

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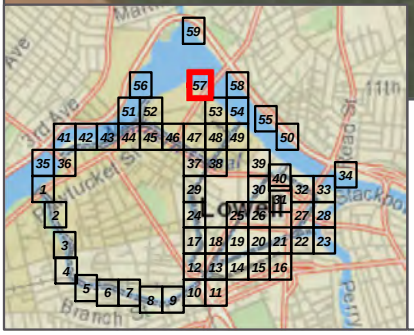

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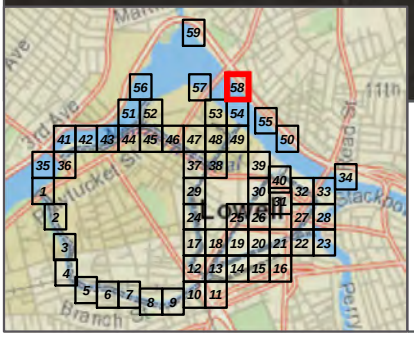

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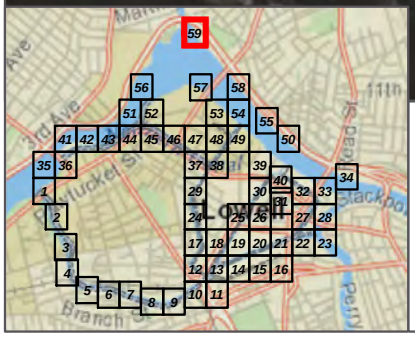

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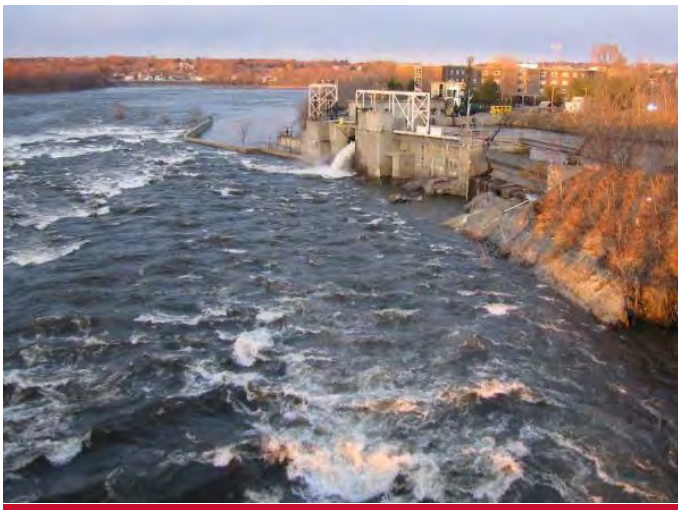

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

February 25, 2021

Prepared by:

FDR

Prepared for:

Boott Hydropower, LLC
Manchester, New Hampshire

Central Rivers Power

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Contents

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Figures

Appendices

List of Acronyms

ADA	Americans with Disabilities Act
AW	American Whitewater
Boott	Boott Hydropower, LLC (or Licensee)
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
Commonwealth	Commonwealth of Massachusetts
DBH	diameter at breast height
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission (or Commission)
FGMP	Final General Management Plan
GIS	Geographic Information System
GPS	Global Positioning System
ILP	Integrated Licensing Process
ISR	Initial Study Report
LNHP	Lowell National Historical Park
MADCR	Massachusetts Department of Conservation and Recreation
MADEM	Massachusetts Department of Emergency Management
MEOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
MOU	memorandum of understanding
MW	megawatt
NGVD 29	National Geodetic Vertical Datum 1929
NHDES	New Hampshire Department of Environmental Services
NHDNCR	New Hampshire Department of Natural and Cultural Resources
NHFGD	New Hampshire Fish and Game Department
NHL	National Historic Landmark
NOI	Notice of Intent

NPS	National Park Service
NRPC	Nashua Regional Planning Commission
OSRP	Open Space and Recreation Plan
PAD	Pre-Application Document
Project	Lowell Hydroelectric Project (or Lowell Project)
Proprietors	Proprietors of the Locks and Canals
PSP	Proposed Study Plan
RM	river mile
RMP	Resources Management Plan
ROR	run-of-river
RSP	Revised Study Plan
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SPD	Study Plan Determination
Study Workshop	Lowell Hydroelectric Project Study Workshop
USFS	U.S. Forest Service
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
Visitor Center	E.L. Field Powerhouse Visitor Center
VP	vegetation point

1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20.2-megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

In accordance with 18 C.F.R. § 5.15, Boott has conducted studies as provided in the study plan and schedule approved in the Commission's March 13, 2019 Study Plan Determination (SPD) for the Project.[1] This report describes the methods and results of the approved Recreation and Aesthetics Study conducted in support of a new license for the Project.

1.1 Project Description and Background

The Lowell Project is located at river mile (RM) 41 on the Merrimack River in the City of Lowell in Middlesex County, Massachusetts, with an impoundment extending approximately 23 miles upstream into Hillsborough County, New Hampshire. The existing Lowell Project consists of:

1) A 1,093-foot-long, 15-foot-high masonry gravity dam (Pawtucket Dam) that includes a 982.5-foot-long spillway with a crest elevation of 87.2 feet National Geodetic Vertical Datum 1929 (NGVD 29) topped by 5-foot-high pneumatically-operated crest gates deployed in five independently-operable zones;
2) A 720-acre impoundment with a normal maximum water surface elevation of 92.2 feet NGVD 29;
3) A 5.5-mile-long canal system which includes several small dams and gatehouses;
4) A powerhouse (E.L. Field) which uses water from the Northern Canal and contains two turbine-generator units with a total installed capacity of 15.0 megawatts (MW);
5) A 440-foot-long tailrace channel;
6) Four powerhouses (Assets, Bridge Street, Hamilton, and John Street) housed in nineteenth century mill buildings along the Northern and Pawtucket Canal systems containing 15 turbine-generator units with a total installed capacity of approximately 5.1 MW;

[1] The Commission issued a Revised Process Plan and Schedule on June 12, 2020.

7) A 4.5-mile-long, 13.8-kilovolt transmission line connecting the powerhouses to the regional distribution grid;

8) Upstream and downstream fish passage facilities including a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam; and

9) Appurtenant facilities.

At the normal pond elevation of 92.2 feet NGVD 29 (crest of the pneumatic flashboards), the surface area of the impoundment encompasses an area of approximately 720 acres. The gross storage capacity between the normal surface elevation of 92.2 feet and the minimum pond level of 87.2 feet is approximately 3,600 acre-feet. The Project operates essentially in a run-of-river (ROR) mode using automatic pond level control and has no usable storage capacity.

The Project's primary features are located along the Merrimack River in the City of Lowell, Massachusetts. The City of Lowell was founded in the early 1820s by Boston merchant capitalists and became one of the most significant planned industrial cities in America (Hay 1991). Lowell's factory system, which used the waterpower of the Merrimack River, incorporated new technologies to provide for the mass production of cotton cloth in mills throughout the city (National Park Service [NPS] 1981). Lowell established the pattern for large-scale waterpower development for the next 50 years (Hay 1991).

Several Project facilities are located within overlapping locally, state, and nationally designated parks and historic properties/preservation districts. The Project's Pawtucket Dam and E.L. Field Powerhouse are located along the mainstem of the Merrimack River. The Project's two-tiered network of man-made canals extends throughout downtown Lowell. The 5.5-mile-long canal system provides flow to the Project's Hamilton, Assets, Bridge Street, and John Street developments. The Hamilton, Assets, Bridge Street, and John Street power stations and turbines are housed in large former mill buildings. The mill buildings are not included in the Project; the Project Boundary includes only the turbines and associated waterways and equipment at these downtown mill sites. In addition to the Pawtucket Dam and hydroelectric developments, the Project also includes miscellaneous civil works in the City of Lowell, including the Guard Lock and Gates, Moody Street Feeder Gatehouse, Lawrence Dam, Hall Street Dam, Tremont Wasteway, Lower Locks and Dam, Swamp Locks and Dam, Merrimack Dam and Merrimack Gate, Rolling Dam, and the Boott Dam.

The canal system, the downtown mill sites, and many of the Project's civil works, are contributing resources to Lowell Locks and Canals National Historic Landmark (NHL) District. The canal system and many Project facilities are also located within the Lowell National Historical Park (LNHP) managed by the NPS and the larger Lowell Historic Preservation District. The LNHP was established by Congress in 1978 to "preserve and interpret the nationally significant historical and cultural sites, structures, and districts in Lowell, Massachusetts, for the benefit and inspiration of present and future generations." The park is by design a partnership park in which federal, state, and local governments

as well as the private sector and local community carry out the legislative intent of the park unit. The Lowell National Historical Park is also listed on the National Register of Historic Places (NRHP), and certain properties within the park overlap with properties in the NHL District.

The Lowell Heritage State Park, established in 1974 as a precursor to the LNHP, is also located within the City of Lowell and is comprised of linear greenways along the Merrimack River and canal system and a collection of historic buildings and structures related to the industrial development of the city. These buildings and structures include Project features and properties located within the NHL District. The Lowell Heritage State Park is operated by the Massachusetts Department of Conservation and Recreation (MADCR) and features exhibits created in partnership with the NPS (MADCR 2018). With the exception of the Rynne Bathhouse, all of the built resources within the Lowell Heritage State Park fall within the Lowell Historic District, designated by the City of Lowell to "…ensure that development activities within the district are consistent with the preservation of its 19th century setting" (MADCR 2014). Portions of the Lowell Heritage State Park also overlap with the Lowell Locks and Canals NHL District and the LNHP.

On April 30, 2018, Boott initiated the ILP by filing a Pre-Application Document (PAD) and Notice of Intent (NOI) with the Commission. Major ILP milestones to-date are presented in Table 1-1.

Table 1-1. Major ILP Milestones Completed

Date	Milestone
April 30, 2018	PAD and NOI Filed
June 15, 2018	Scoping Document 1 (SD1) Issued by FERC
July 17, 2018	FERC Agency and Public Scoping Meetings Conducted
July 18, 2018	Project Site Visit Held
September 27, 2018	Scoping Document 2 (SD2) Issued by FERC
September 28, 2018	Proposed Study Plan (PSP) Filed
October 18 & 19, 2018	PSP Meeting Conducted
January 28, 2019	Revised Study Plan (RSP) Filed
March 13, 2019	FERC Issued SPD
February 25, 2020	Initial Study Report (ISR) Filed
March 11, 2020	ISR Meeting
June 12, 2020	FERC Issued Revised Process Plan and Schedule
September 30, 2020	Revised ISR Filing
December 2, 2021	Draft License Application (DLA) filed
February 2, 2021	FERC Issued Determination on Requests

Boott has continued consultation with stakeholders regarding the approved studies as required by the Commission's SPD. In accordance with the schedule presented in the RSP, Boott has also provided stakeholders with Quarterly ILP Study Progress Reports that include a description of study activities conducted during the previous quarter, activities expected to occur in the next quarter, and identified variances from the approved study plan.

1.2 Project Recreation Facilities

Pursuant to existing License Article 38 and the FERC-approved Recreation Plan, Boott maintains the E. L Field Powerhouse Visitor Center (Visitor Center). The Visitor Center is the Project's only FERC-approved recreation facility. The Visitor Center offers a secured view of the interior of the turbine gallery and an interpretive display which provides information regarding the development, history, and operation of the Project and nearby historic, natural, cultural, and recreational resources.

Non-Project related recreational facilities and opportunities in the Project's vicinity include the Depot Street Boat Ramp, Greely Boat Ramp, LNHP, Lowell Heritage State Park, Merrill Park, Moore's Falls Conservation Area, and the Rourke Brothers Boat Ramp. The Merrimack River provides extensive recreational opportunities, including boating, canoeing, kayaking, rowing, fishing, and swimming. The surrounding vicinity is used for hiking, picnicking, bird watching, nature study, and overall enjoyment of scenic views.

2 Study Goals and Objectives

The goals of this study are to (a) document recreation resources and recreational activities that occur in the Project area; (b) determine the adequacy and capacity of existing recreational facilities to accommodate proposed enhancements and/or additional recreational activities; (c) assess potential effects of water levels and flow rates on existing recreational facilities; (d) assess the potential for expanded access to the canal system for recreation; and (e) identify areas within the canal system where vegetation growth on historic canal walls and waterborne trash are a concern.

The specific objectives of the study are to:

- Identify existing recreation facilities in the Project area;
- Quantify current recreational use based on recent and new surveys and interviews, and consultation with stakeholders, regional and statewide plans, and other available data (including NPS and MADCR planning documents);
- Identify proposed recreational uses based on surveys and interviews in consultation with stakeholders;
- Evaluate the potential effects of continued operation of the Project (including water levels and flow rates) on recreation resources and activities in the Project area;

- Assess the potential for expanded recreational access to the canal system in consultation with the NPS, MADCR, the City of Lowell, Lowell Parks and Conservation Trust, the Lowell Heritage Partnership, and other partners in recreation;
- Identify areas of concern related to waterborne trash and vegetation growth on historic canal walls and other structures or historic properties owned or under the control of Boott; and,
- Gather information on the condition of Boott's recreation facilities and identify any need for improvement.

3 Study Area

In accordance with the Commission's SPD, the study area for the Recreation and Aesthetics Study is a general area that includes the existing FERC Project Boundary and adjacent recreation facilities (Figure 3-1, Figure 3-2).

Figure 3-1. Existing Project Location and Boundary

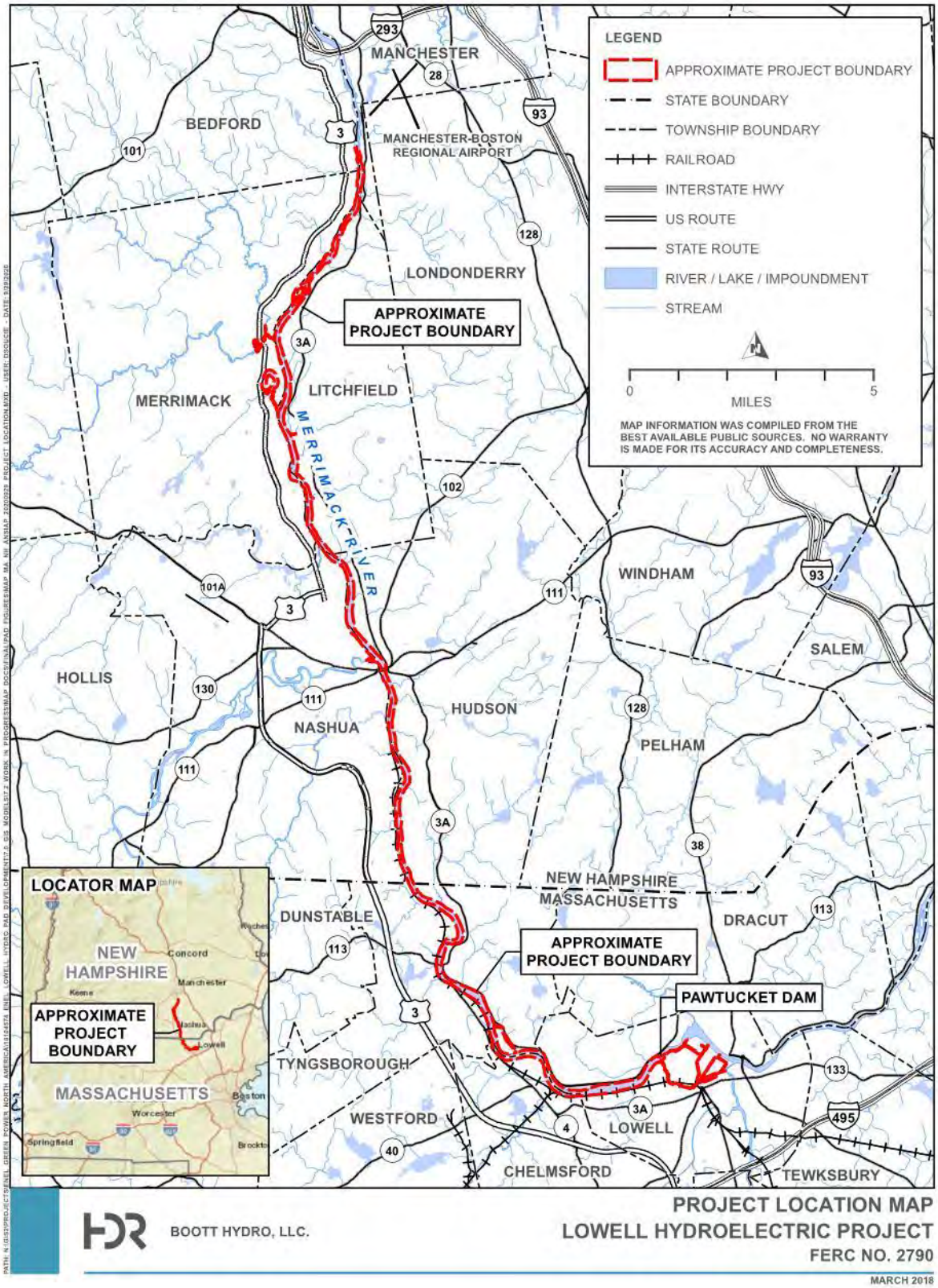


Figure 3-2. Existing Project Boundary and Facilities in Downtown Lowell

4 Methodology

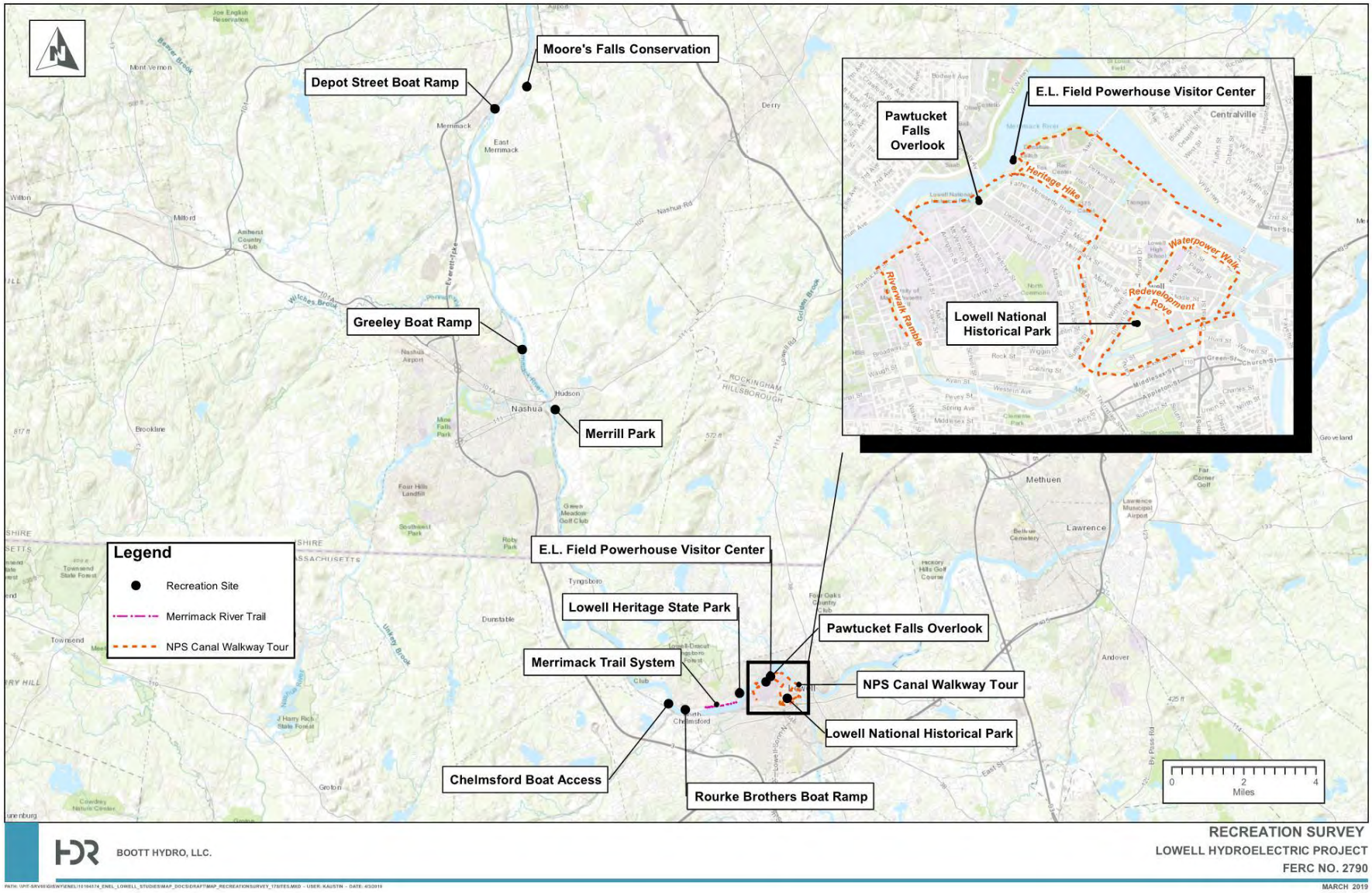
4.1 Literature Review

Boott conducted desktop research and a literature review to identify and describe recreational uses in the Project area, including (but not limited to) whitewater boating, canoeing, kayaking, fishing, swimming, walking, and architectural/historical tours. As a component of this research, Boott reviewed existing recreational uses, facilities management plans (as applicable), and limitations and regulations applicable to the Project area. Additionally, Boott conducted a records search and literature review on the historical and current practices regarding vegetation and waterborne trash management and control on historic canal walls and other structures or historic properties owned or under the control of Boott.

4.2 Field Inventory

Boott conducted a field inventory to document existing non-Project recreation facilities within the Project's vicinity in the fall of 2019. Recreation sites inventoried included the Moore's Falls Conservation Area, Depot Street Boat Ramp, Chelmsford Boat Access, Greeley Boat Ramp, the Rourke Brothers Boat Ramp, Lowell Heritage State Park, Merrimack Trail System, LNHP, Merrill Park, NPS Canal Walkways, and Pawtucket Falls Overlook (Figure 4-1). The Visitor Center, the only Project-related recreation facility, was also inventoried. Pursuant to the RSP, Boott collected information regarding each facility including the type and location of existing recreation facilities, the type of recreation provided (e.g., boat access, angler access, picnicking, etc.), existing amenities and sanitation, the type of vehicular access and parking (if any), the suitability of facilities to provide recreational opportunities and access for persons with disabilities (i.e., compliance with current Americans with Disabilities Act [ADA] standards for accessible design), Global Positioning System (GPS) location data, and representative photographic documentation of recreation facilities.

Figure 4-1. Recreation Field Inventory Locations



4.3 Collection of Visitor Use Data and Field Reconnaissance

4.3.1 Personal Interviews and Field Reconnaissance

As provided in the approved study plan, Boott conducted personal interviews (visitor-intercept surveys) and field reconnaissance activities at recreation facilities in the Project's vicinity between May and October 2019. Boott conducted field reconnaissance and personal interview surveys on random weekdays and weekend days throughout the months of May, June, July, August, September, and October of 2019. Personal interviews and field reconnaissance were conducted on four days of each month on both weekdays, weekend days, and holidays. The actual dates that personal interviews and field reconnaissance took place in 2019 are presented in Table 4-1.

Table 4-1. Personal Interviews and Field Reconnaissance Schedule

Month	Specific Dates
May	• Saturday May 25, 2019 • Sunday May 26, 2019 • Monday May 27, 2019 • Tuesday May 28, 2019
June	• Friday June 7, 2019 • Monday June 10, 2019 • Saturday June 15, 2019 • Sunday June 16, 2019
July	• Wednesday July 10, 2019 • Friday July 19, 2019 • Saturday July 27, 2019 • Sunday July 28, 2019
August	• Tuesday August 6, 2019 • Sunday August 18, 2019 • Wednesday August 21, 2019 • Saturday August 24, 2019
September	• Saturday September 14, 2019 • Thursday September 19, 2019 • Sunday September 22, 2019 • Wednesday September 25, 2019
October	• Wednesday October 9, 2019 • Tuesday October 15, 2019 • Saturday October 19, 2019 • Sunday October 27, 2019

Boott developed survey questions based on general concepts and guidance from the U.S. Forest Service's (USFS) National Visitor Use Monitoring Handbook (USFS 2007) and questions that were asked during recreation studies for other relevant hydropower relicensings. The survey questions that were asked during the personal interviews are included in Appendix A of this study report. Boott consulted with the NPS, MADCR, and

American Whitewater (AW) to identify specific recreation survey locations. The selected locations for the personal interviews and field reconnaissance (Figure 4-1) were:

- Lowell Heritage State Park
- Merrimack Trail System
- Pawtucket Falls Overlook
- NPS Canal Walkways
- LNHP Visitor Center
- Chelmsford Boat Access
- Rourke Brothers Boat Ramp
- Merrill Park, and
- Whitewater takeout location[2]

A team of two technicians traveled between each of the selected recreation sites and spent approximately one hour at each site conducting the personal interviews and collecting field reconnaissance data including (a) the various types of recreation activities, (b) an estimation of the number of vehicles, and (c) the approximate numbers of recreationists observed at each site. Before rotating to the next site, technicians also recorded the date, time, and weather conditions observed. For the personal interviews, individual recreationists and groups were interviewed, including visitors using boat launches and LNHP-managed facilities. Respondents answered questions verbally while a technician recorded their responses using the Qualtrics® offline survey platform to record and submit answers.[3] The personal interview questions included topics such as: general user information; age group, resident/visitor; purpose and duration of visit; distance traveled; history of visiting the site or area; types of recreational activities respondents participated in or planned to participate in during their visit; other recreational sites that respondents visited or intended to visit during their trip; general satisfaction with recreational opportunities, flow conditions, facilities, and the respondents overall visit and/or areas that need improvement; accessibility of facilities or areas; economic aspects, including dollars spent during their trip; and day use/overnight lodging during their visit.

4.3.2 Online Visitor Use Surveys

In addition to the personal interviews, Boott developed a version of the interview questions to allow respondents to provide survey responses online. In accordance with the approved study plan, the survey was made available for one year, from June 2019 to June 2020, on the Project's relicensing website (www.lowellprojectrelicensing.com). The

[2] The Whitewater takeout location is not identified on Figure 4-1. This informal non-Project recreation area is located along the riverfront behind Edward A. Lelacheur Park.

[3] While the survey questions in the approved study plan were utilized for these interviews, the numbering and specific wording was adapted during the interview to better facilitate the interview and to accommodate the Qualtrics® survey platform.

online survey was developed using the Qualtrics® survey platform. Boott posted a brief description of the purpose and intent of the survey and the website address at popular recreation access areas at the Project (Photo 4-1). During personal interviews and field reconnaissance, Boott provided handouts to recreationists with the relevant information on how to access the online survey. Boott notified the Commission and stakeholders of the availability of the online survey in the Second Quarterly Study Progress Report filed with the Commission on October 1, 2019. The survey questions developed for the online survey are also included in Appendix A of this study report.

Photo 4-1. Example of Signage for Participating in Online Visitor Use Surveys

4.4 Evaluation of Expanded Recreational Access in Project Canals

NPS and NPS partners have expressed interest in new, different, and expanded recreational access to and within the Project canals. Boott consulted with the NPS to discuss various recreational opportunities based on the NPS's plans for developing recreational access within the LNHP and the visitor use data collected pursuant to Section 4.3 of this report.

Boott conducted an evaluation of prospective recreation access. This evaluation considered:

- Public safety concerns associated with canal access;

- Infrastructure enhancement that may be required to provide safe public access to the canal system and how such improvements may affect aesthetic and historic resources; and,
- Potential options for improving canal system access, such as operational changes or other measures.

4.5 Documentation of Current Water Levels and Flows

In accordance with the SPD, Boott initiated the data collection associated with the Water Level and Flow Effects on Historic Resources Study and the Operations Analysis of the Lowell Canal System Study, both to be filed with FERC by February 25, 2021. Pressure transducers (level loggers) were installed in the Project's canal system in 2019. On December 18, 2019, Boott held a Lowell Hydroelectric Project Study Workshop (Study Workshop)[4] with stakeholders and refined the data needs for this study based on consultation with the NPS and NPS partners. This included moving the level loggers to locations in the Upper Pawtucket Canal and Northern Canal on March 10, 2020 to better understand and collect data regarding the effects of the crest gate on NPS boat tours and access to the Northern Canal Walkway. These level loggers were removed on September 23, 2020.

4.6 Visual Survey for Vegetation Growth

The visual survey for vegetation growth was conducted between September 25 and 27, 2019. The visual survey was conducted to identify vegetation growth along the canal walls within the study area. Technicians identified the relative quantity and spatial distribution of each vegetation type using aerial photography and observations of habitat and specific plant species occurrences. The methods for this study followed those that were described in the study plan approved by the Commission.

4.6.1 Review of Existing Information

Terrestrial vegetation types occurring in the study area were described based on a review of existing information, an inspection of aerial photography, a review of the U.S. Geological Survey (USGS) 7.5-minute quadrangles, and observations of habitat and specific vegetation type occurrences during the field surveys. Sources of existing information included but were not limited to the following:

- Massachusetts Natural Heritage and Endangered Species Program Classification of the Natural Communities of Massachusetts (Swain 2020): provides a basis for the discussion and conserving the diversity of the types of natural communities and the species they support within the Commonwealth of Massachusetts (Commonwealth). The primary aim of the classification is to describe the natural communities that are

[4] The meeting minutes of the December 18, 2019 Study Workshop were appended to the ISR filed with FERC on February 25, 2020.

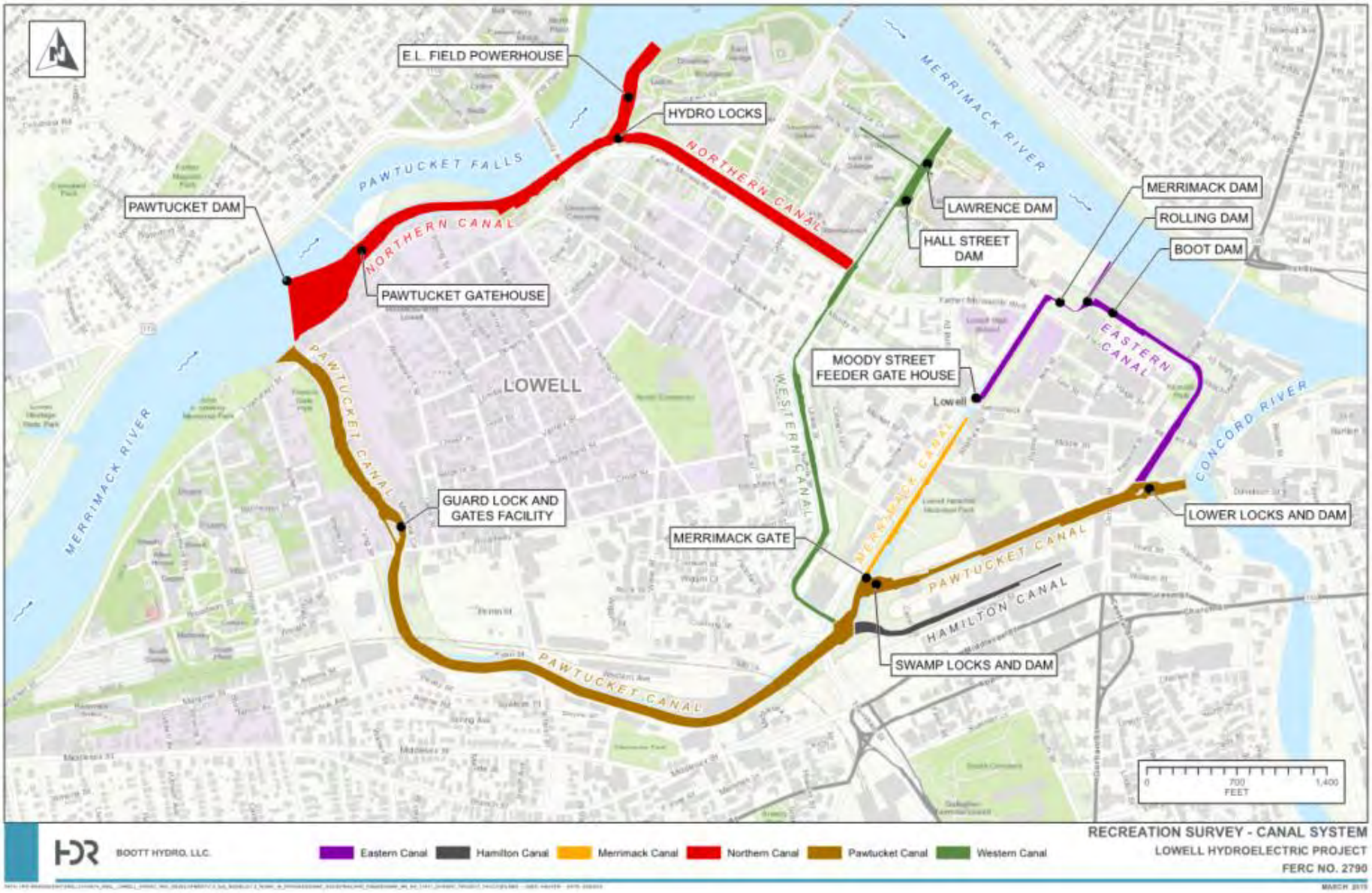
of conservation interest, while also including all types of natural communities in the state.

- Flora of the Northeast – A Manual of the Vascular Flora of New England and Adjacent New York (Magee and Ahles 1999): a reference work and year-round field manual that contains more than 2,400 range maps and over 900 line drawings for identifying the vascular flora of New England and New York.
- Invasive Plants (Kaufman and Kaufman 2007): a guide to the identification and the impacts and control of common North American invasive plant species.

4.6.2 Mapping of Vegetation Growth on Canal Walls

For the purposes of examining vegetation type distribution, the study area was divided into the six canals associated with the Lowell Project canal system including: 1) Pawtucket Canal; 2) Northern Canal; 3) Western Canal; 4) Merrimack Canal; 5) Eastern Canal; and 6) Hamilton Canal (Figure 4-2).

Figure 4-2. Visual Survey for Vegetation Growth Study Area



Visual qualitative surveys were conducted in the study area by foot along the shorelines of the canals, or via an NPS boat for the surveys conducted in the Pawtucket Canal from the Swamp Locks and Dam to the Merrimack River. Vegetation was characterized by dominant type (i.e., Herbaceous, Scrub-Shrub, Trees, Forested, or Mixed) (Table 4-2). The vegetation type assessments were based on overall dominant vegetation characteristics at the time of the survey that may have variations within small areas. In addition, the shoreline/canal was characterized by dominant features (i.e., Block Wall, Concrete, Earthen/Terrestrial Cultural, Stone Wall, Block Wall/Concrete/Stone Wall Mix) (Table 4-3). The shoreline/canal type assessments were based on overall dominant features at the time of the survey that may have variations within small areas.

Table 4-2. Dominant vegetation types used during field surveys

Vegetation Type	Description
Herbaceous	Characterized by primarily herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants less than 3 feet tall.
Scrub-Shrub	Consists of woody plants less than 3 inches diameter at breast height (DBH) and greater than or equal to 3 feet tall.
Trees	Consists of woody plants 3 inches or more in DBH, regardless of height. This vegetation type description was generally used to describe areas along canal walls where only a few trees were growing in a clump.
Forested	Characterized as a relatively large area that consists of primarily trees and underbrush.
Mixed	Characterized by a mosaic of herbaceous, scrub-shrub, and/or trees.

Table 4-3. Dominant shoreline/canal types used during field surveys

Shoreline/Canal Type	Description
Block Wall	Canal walls primarily dominated by placed, generally uniform sized blocks with concrete caps or block alone.
Concrete	Canal walls primarily dominated by concrete, with various types of cement and aggregate.
Earthen/Terrestrial Cultural	Canal walls generally dominated by earthen embankments (forested and unforested) and areas of exposed bedrock. Some of these areas (e.g., riprapped areas) have been created and/or maintained by human activities.
Stone Wall	Canal walls primarily dominated by placed, generally non-uniformly sized blocks with concrete caps or block alone.
Block Wall/ Concrete/Stone Wall Mix	Areas of canal walls predominantly composed of a conglomeration of block wall, concrete, or stone wall at varying quantities.

Mapped Vegetation Polygons and Vegetation Points (VPs)[5] were located using an EOS Positioning Systems Arrow 100™ GNSS receiver linked to an iPad™ Air 2 or Android device operating Collector for ArcGIS™ hand-held GPS unit (equipped with a data dictionary aiding in feature attribution). The presence and extent of cover of the vegetation on/along the canal walls observed at the time of the field survey was evaluated based on photographs and field observations. Geospatial vegetation data were transferred to a Geographic Information System (GIS) format and used to develop both visual maps depicting vegetation presence boundaries and VPs along the canal walls as well as tabular information quantifying the abundance and distribution of dominant vegetation types in the study area. Vegetation polygons were then analyzed to calculate the percentage represented by each vegetation category within each canal; VPs were not included in vegetation category percentage calculations because they represent a single point on the canal wall.

Each representative vegetation type was photographed. Each vegetation polygon and VPs, including any canal descriptive features (e.g., riprap, concrete walls, earthen embankments, etc.) within a polygon or near a VP, was photo documented when possible.

4.6.3 Data Analysis and Processing

During the field effort, mapped vegetation type polygons were collected to represent current conditions. Vegetation type boundaries were mapped to reflect field observations of vegetation composition.

Upon completion of the field data collection effort, all data were checked for errors and omissions. The percentages of each vegetation type were calculated. Minor adjustments were made to a small number of vegetation polygon boundaries and subsequent percentages based on examination of the location of the GPS polygon data relative to banks and bends along the canals, or from recorded field data during mapping.

4.7 Visual Survey for Waterborne Trash

The visual survey for waterborne trash was formally conducted on April 9, 2020. The survey was conducted to identify locations within the study area where waterborne trash accumulates within the Project Boundary. Waterborne trash occurring along the canals was described based on observations of accumulated waterborne trash during the field reconnaissance survey. The methods for this study followed those that were described in the study plan approved by the Commission.

[5] Vegetation points were used to identify areas along canal walls where a single vegetation type point was recorded. Vegetation points generally identify where a single species (e.g., shrub, tree) was located.

4.7.1 Review of Existing Information

Areas of waterborne trash occurring in the study area were described based on a review of existing information, an inspection of aerial photography, the observation of accumulated waterborne trash during other Project relicensing studies, a review of information provided to Boott by the NPS that identifies areas of trash accumulation (both on the canal bottom and waterborne) within the study area, as well as the specific waterborne trash occurrences during the field survey.

4.7.2 Waterborne Trash Mapping

For the purposes of examining waterborne trash accumulation areas, the study area was divided into the six canals associated with the Lowell Project canal system including: 1) Pawtucket Canal; 2) Northern Canal; 3) Western Canal; 4) Merrimack Canal; 5) Eastern Canal; and 6) Hamilton Canal, and associated NPS gatehouses and locks (Figure 4-2).

Visual qualitative surveys were conducted in the study area by vehicle as well as on foot along the shorelines of the canals. Waterborne trash was characterized by dominant type (i.e., Plastics/Household, Woody Debris, or Assorted) (Table 4-4). The canal level (low, medium, high) at the time of the site investigation was also recorded. The waterborne trash assessments were based on the overall dominant trash type observed at the time of the survey.

Table 4-4. Dominant Waterborne Trash Types Used During Field Surveys

Waterborne Trash Type	Description
Plastics/Household	Characterized by plastic cups, plastic bags, wrapping materials, plastic water bottles, plastic containers, rubber balls, fast-food wrappers, shoes, construction barrels, etc.
Woody Debris	Characterized by trees, logs, branches, stumps, boards, sections of plywood, etc.
Assorted	Characterized by a conglomeration at varying densities of plastics/household and woody debris.

Mapped areas of waterborne trash were located using an EOS Positioning Systems Arrow 100™ GNSS receiver linked to an iPad™ Air 2 or Android device operating Collector for ArcGIS™ hand-held GPS unit (equipped with a data dictionary aiding in feature attribution). The presence and extent of waterborne trash within the canals observed at the time of the field survey was evaluated based on field observations and photographs. Geospatial waterborne trash data were transferred to a GIS format and used to develop both visual maps depicting mapped areas of accumulated waterborne trash within the canals as well as tabular information describing the abundance and distribution of waterborne trash in the study area. The mapped polygons were then analyzed to calculate the area represented by each dominant trash type within each canal.

Each representative trash type was photographed. Each waterborne trash polygon, including any canal descriptive features (e.g., active construction adjacent to canal, primarily residential, commercial, etc.) in the vicinity of a polygon, was photo documented when possible.

4.7.3 Data Analysis and Processing

During the field effort, mapped waterborne trash polygons were collected to represent current conditions. Waterborne trash polygon boundaries were mapped to reflect field observations at the time of the investigations.

Upon completion of the field data collection effort, all data were checked for errors and omissions. The areas of each mapped waterborne trash polygon were calculated. Minor adjustments were made to a small number of mapped waterborne trash polygon boundaries and subsequent areas based on examination of the location of the GPS polygon data relative to banks and bends along the canals, or from recorded field data during mapping.

5 Study Results

5.1 Literature Review

Pursuant to the approved study plan, Boott reviewed several sources to summarize recreation in the Project area, including the Massachusetts Statewide Comprehensive Outdoor Recreation Plan (SCORP) (Massachusetts Executive Office of Energy and Environmental Affairs [MEOEEA] 2017); the New Hampshire Department of Natural and Cultural Resources (NHDNCR) SCORP 2018; the Massachusetts Recreational Trails Program Guide (MassTrails) 2020; the LNHP Foundation Document (LNHP 2017); The City of Lowell Open Space and Recreation Plan (City of Lowell 2018); and the City of Lowell's Comprehensive Master Plan, known as Sustainable Lowell 2025 (City of Lowell 2013). Additionally, Boott conducted a records and literature review on the historical and current practices regarding management of vegetation growth and waterborne trash. This section summarizes the results of the literature review to characterize these aspects in the Project area.

5.1.1 Recreation in the Project Area

The Merrimack River provides widespread recreational opportunities. The 116-mile-long Merrimack River begins at the confluence of the Winnipesaukee and Pemigewasset Rivers in the City of Franklin, New Hampshire, flows southward into Massachusetts, and then travels northeast until it discharges into the Atlantic Ocean (New Hampshire Department of Environmental Services [NHDES 2019]). Although the Merrimack River watershed is heavily forested (75% of the land area is covered with forest), it also supports all or parts of approximately 200 communities with a total population of 2.6

million people (Environmental Protection Agency [EPA] 2020; U.S. Army Corps of Engineers [USACE] 2006). The Merrimack River provides numerous recreational opportunities to the residents of the communities along its banks but is also utilized by residents of major cities in the region, particularly residents from Boston (Nashua Regional Planning Commission [NRPC] 2008; NHDES 2019; USACE 2006).

The Project dam is located at river mile 41 on the Merrimack River, and the impoundment extends upstream approximately 23 miles almost to the City of Manchester in New Hampshire. The Project impoundment is characterized by the urban/industrialized cities of Nashua, New Hampshire and Lowell, Massachusetts. Recreational opportunities differ closer to these larger, more populated cities along the river. The State of New Hampshire reports many recreational uses of the Project impoundment, including fishing, canoeing, kayaking, rowing, and motor boating. Lands adjacent to the Project impoundment are used for hiking, picnicking, birdwatching, nature study, and overall enjoyment of the scenic views (NHDES 2019; NHDNCR 2018; New Hampshire Fish and Game Department [NHFGD] 2020; NHFGD 2016).

The state of Massachusetts reports that recreation along the Project impoundment changes as open space generally decreases further downstream and riverfront communities are more industrialized (MEOEEA 2001). Water-based recreation (boating, fishing, canoeing, and swimming), is provided on the downstream portion of the Project impoundment by multiple boat ramps and waterfront parks. The City of Lowell, NPS, and MADCR report many additional recreational opportunities in and surrounding Lowell, including networks of trails, thousands of acres of nearby state forest, and urban passive parks for walking, jogging, dog-walking, and picnicking (City of Lowell 2018; MADCR 2014; LNHP 2017). As part of the LNHP or Lowell Heritage State Park, different sites in and around the city of Lowell are related to the historical era of textile manufacturing and offer museum exhibits, walking tours, and interpretive/interactive displays (LNHP 2017; MADCR 2014).

Although portions of the LNHP are within the Project boundary, it is not a FERC-approved recreation facility. As noted above in Section 1.2, the Visitor Center is the Project's only FERC-approved recreation facility. The Visitor Center offers a secured view of the interior of the turbine gallery and an interpretive display which provides information regarding the development, history, and operation of the Project and nearby historic, natural, cultural, and recreational resources.

Recreational opportunities available along the 23-mile impoundment are summarized in Table 5-1 and described in more detail below.

Table 5-1. Recreational Opportunities Available on the Project Impoundment

Recreational Facility	Canoe/Kayak Access	Boat Ramp	Picnic Area	Fishing Access	Trail System	Light Trails	Designated Swimming Area	Visitor Center	Historical/Heritage Exhibits
Moore's Falls Conservation Area	✓		✓	✓	✓	✓			
Depot Street Boat Ramp	✓		✓	✓					
John Bryant River Access	✓		✓	✓					
Thornton's Ferry Boat Launch	✓			✓					
Greeley Park & Boat Ramp	✓	✓	✓	✓	✓	✓			
Merrill Park	✓		✓	✓		✓			
Chelmsford Boat Access	✓	✓	✓	✓	✓				
Rourke Brothers Boat Ramp	✓	✓		✓					
Lowell Heritage State Park			✓	✓	✓	✓	✓		✓
Pawtucket Falls Overlook									✓
Lowell National Historical Park					✓	✓		✓	✓
E.L. Field Powerhouse Visitor Center								✓	✓

Much of the Project impoundment is in Hillsborough County in New Hampshire. The New Hampshire SCORP estimated that the county has approximately 54,480 acres of recreation lands and 116 public access sites to the water. Public lands maintained by state, federal, or local municipalities comprise the majority of identified recreational acreage in the county, followed by private non-profit organizations/land trusts. With an estimated 197 natural/passive recreation areas and 111 parks, picnics, and playground areas, Hillsborough County has the most of all counties in New Hampshire. Given the national trend of individuals choosing to recreate closer to home, the New Hampshire

SCORP states it is important that larger population bases, such as that of Hillsborough County, have higher proportions of recreation sites (NHDNCR 2018).

Most of the shore lands along the Merrimack River in New Hampshire are privately owned. Activities such as boating, canoeing, kayaking, rowing, and fishing take place immediately on the Merrimack River (NRPC 2008). There are six known boat access facilities in New Hampshire with direct access to the Project impoundment. These facilities range in design from concrete ramps to shoreline access and are described below:

Moore's Falls Conservation Area: Moore's Falls Conservation Area offers shoreline fishing and car-top boating access to Moore's Falls in the Project impoundment. Moore's Falls are a length of rapids on the Merrimack River which drop 6 feet in elevation over 650 feet in distance. There are also walking trails through the woods, an old trolly track trail, multiple access points to the Merrimack River for fishing, educational information regarding environmental conservation, and birdhouses. NHDES recommends this conservation area for angler fishing, as small and large mouth bass are often caught, as well as rainbow and brook trout, both of which are stocked by the NHFGD in the Lower Merrimack River (Middlesex Canal Association 2009; NHDES 2019).

Depot Street Boat Ramp: The Depot Street Boat Ramp offers a carry-in boat ramp and fishing access to the Merrimack River and is managed by the Town of Merrimack. The trail to the river runs under railroad tracks. This access is suitable for motorboats, as the river slows from the rocky rapids upstream (NHDES 2019; Merrimack Parks and Recreation 2020). There is also a scenic picnic area.

John Bryant River Access: The John Bryant River Access is a canoe/kayak car top facility managed by the Litchfield Recreation Commission. It provides fishing access, scenic views of the river, and birdwatching. It is available only to Town of Litchfield, New Hampshire residents (Litchfield Recreation Commission 2020).

Thornton's Ferry Boat Launch: Thornton's Ferry Boat Launch is owned by the Town of Merrimack and offers cartop carry-in boating and fishing access to the Merrimack River (NHFGD undated).

Greeley Park & Boat Ramp: Greeley Park is a 125-acre city park located in Nashua, New Hampshire. Greely Park offers many recreation amenities/facilities including baseball/softball fields, historical sites, picnic areas, playgrounds, restrooms, tennis courts, trails, and wading pools (NHFGD undated; City of Nashua 2020). In 2019, the City of Nashua issued an invitation to bid for reconstruction of the Greeley Park Boat Ramp, as well as construction of a gravel parking lot, placement of new signs, and three biological retention ponds. The work was scheduled for completion in July 2020 (NHFGD undated; City of Nashua 2019). A paved ramp at the north end of Greeley Park in Nashua also allows access to the river for boaters. NHDES recommends this conservation area for angler fishing (NHDES 2019).

Merrill Park: Merrill Park is a 9.3-acre city park located in Hudson, New Hampshire. It is adjacent to the east riverbank and Project boundary. The park is mostly forested with a few walking paths and picnic benches. It has a path which leads down to the Merrimack River, allowing hand-carry access for canoes or kayaks, or fishing (Town of Hudson undated).

The Merrimack River provides quickwater and flatwater experiences for canoeists and kayakers and is one of the largest surface water bodies in the region for motor boating. Local watershed organizations sponsor a variety of paddling trips on the Merrimack River and its tributaries throughout the spring, summer, and fall for beginner and intermediate paddlers (NHDES 2017). Upstream of the northern extent of the Project impoundment is a whitewater kayak course located in Manchester, New Hampshire. There are also class I-II+ rapids located between Amoskeag Falls to Goffs Falls (City of Manchester 2018).

The most popular outdoor activities for New Hampshire residents include wildlife observation, driving for pleasure, sightseeing, and jogging/running/walking. Day hiking tends to be more popular in New Hampshire than the national average (NHDNCR 2018). Natural areas in the vicinity of the Project in New Hampshire are also used for cross country skiing, picnicking, bird watching, nature study, and overall enjoyment of scenic views (NRPC 2008). In addition to the facilities mentioned above, the following facilities are within a 30-minute drive from the Project impoundment and are provided for these types of activities:

Litchfield State Forest: The Litchfield State Forest is a 450-acre forest in Litchfield managed by the State of New Hampshire. It is located about 1.5 miles east of the Project boundary. The 1.3-mile Litchfield State Forest Trail provides comfortable walking and biking trails. Off trails provide an additional four miles of hiking, wildlife observation, and scenic opportunities. The trails are often used for cross country skiing in the winter (Litchfield Recreation Commission 2020; ExploreYourSpaces 2020).

Flints Pond Access: Flints pond is a 50-acre, warm water pond located in the Town of Hollis in New Hampshire. The pond is open to the public for fishing, kayaking, and canoeing in the summer. In the winter, ice fishing, snowshoeing, and snowmobiling are also popular. A boat ramp is available at the north end of the pond (Flints Pond Improvement Association 2015). Flints Pond Access is approximately 0.2 miles west of the Project boundary.

Horse Hill Nature Preserve: Horse Hill Nature Preserve is a 560-acre property owned by the town of Merrimack, located about three miles west of the Project Boundary. It is primarily a mixed hardwood forest, with a series of streams, ponds, swamps, and numerous wetlands. Old logging roads form the basis of what is today a trail network used by hikers, bikers, cross country skiing, snowshoeing, hunters, snowmobilers, and horseback riders. This trail network covers most of the property, however, there are still large areas without defined access.

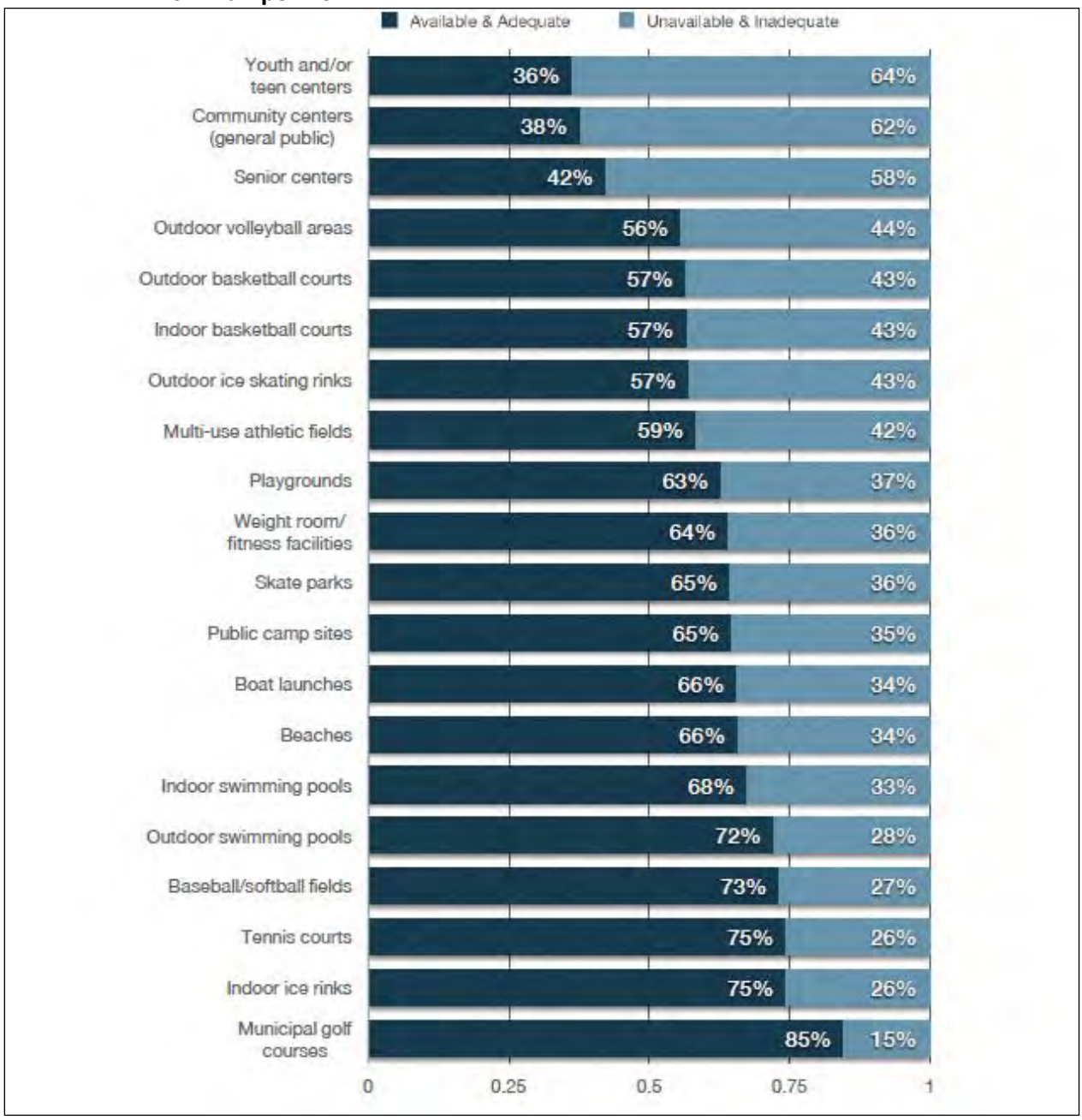
Leslie Bockes Memorial Forest: Forest Society owns and manages this approximately 226-acre forest located in Londonderry, New Hampshire (five miles east of the Project boundary). Nearly four miles of old logging roads provide hiking, skiing, and snowshoeing with numerous access points. The trails are on well-maintained woods roads that enable easy walking and generally good footing. The tract is a known spot for bird and nature-watching (Forest Society 2020).

Twin Bridge Park: Twin Bridge Park is in Merrimack, New Hampshire, and features a baseball field, playground, picnic area, and extensive hiking trails through 27 acres of woods along Baboosic Brook (Town of Merrimack undated). Twin Bridge Park is approximately 0.2 miles west of the Project boundary.

New Hampshire Heritage Trail: The completed trail system will connect trail segments along the Lower Merrimack River and ultimately extend south into Massachusetts, and north along the Merrimack, Pemigewasset, and Connecticut Rivers to the Canadian border. Several trail sections have been completed along this part of the river and northward, with existing segments in Nashua, Hooksett and Manchester, New Hampshire (NHDES 2019).

The most recent New Hampshire SCORP was developed in 2018 for the 2019-2023 program years (NHDNCR 2018). The primary goals of the New Hampshire SCORP are to identify outdoor recreation trends, needs, and issues for New Hampshire, as well as to provide a strategic plan to address changing recreation needs, conservation of natural resources, and the economic vitality of communities. Municipal officials in New Hampshire reported the availability and adequacy of developed recreation facilities and amenities to meet needs within their communities. Figure 5-1 below shows the facilities in order of greatest need in New Hampshire. Municipal officials reported youth and/or teen centers as least available and adequate to meet growing needs, while reporting indoor ice rinks and municipal golf courses as most available and adequate to meet needs. The most relevant to the Project of these rated recreation facilities and amenities in New Hampshire are state/municipal parks, beaches, boat launches, and public camping sites, all of which were identified as being at least moderately available and adequate to meet recreation needs (>50%).

Figure 5-1. Availability and Adequacy of Developed Recreation Facilities/Amenities in New Hampshire



Source: NHDNCR 2018

The Massachusetts SCORP (MEOEEA 2017) is a planning document that discusses the available recreational resources in a state, as well as its changing recreation needs. In drafting of the SCORP, the Massachusetts Executive Office of Energy and Environmental Affairs hosted a series of public meetings across the state in the fall of 2017. Online surveys were also utilized to gather input from both residents and recreation providers. Around 780 citizens responded to the resident survey and 58

municipalities and 38 land trusts responded to the recreation provider survey. The Massachusetts SCORP categorized the most common recreational activities as either water-based recreation (e.g. boating, fishing, swimming at beach/lake/river) or trail-based recreation (e.g., hiking, biking, cross-country). The nearness of an outdoor recreation facility to home was the top reason that it was visited most frequently. Accordingly, when asked to identify the most-needed improvements, recreationists identified trail and water-based recreation enhancements. Massachusetts municipalities reported the highest funding priorities for the next five years are playgrounds, ballfields (soccer, lacrosse, baseball, etc.), community or regional trail systems, and improved pedestrian access to parks (sidewalks, safe road crossings, etc.).

The downstream portion of the Project impoundment is accessible for water-based recreation by the following recreational facilities in Massachusetts:

Lowell Heritage State Park: The 83-acre Lowell Heritage State Park occupies a 2-mile long stretch along the north bank of the Project impoundment, upstream of the Pawtucket Dam. The park features historical exhibits that were created in partnership with the NPS to educate the public regarding the network of canals and mills constructed in the 19th century to power Lowell's then bustling textile industry. Activities available include biking, boating (non-motorized and motorized), canoeing and kayaking, swimming, fishing, hiking, and educational programs. Facilities include a paved bike path and walking esplanade, picnic area, a beach, restrooms, scenic viewing area, an outdoor concert stage, and visitors center (Commonwealth of Massachusetts 2018a). Also located within the park boundary is the University of Massachusetts Lowell Bellegarde Boathouse, which also houses the Merrimack River Rowing Association, a non-profit rowing club.

Rourke Brothers Boat Ramp (part of the Lowell Heritage State Park): The park provides a trailered boat launch, located on the north bank of the impoundment about 2 miles upstream of the Pawtucket Dam. Adjacent to the boat launch is an access dock for boating and fishing.

Chelmsford Boat Access: The park provides a trailered boat launch, shoreline fishing access, picnic areas, athletic fields, and trails.

The Resource Management Plan (RMP) for the MADCR Lowell/Great Brook Planning Unit (MADCR 2014) reports the following recreational facilities within the planning unit, located within a 30-minute drive from the Project boundary:

Lowell-Dracut Tyngsborough State Forest: The Lowell-Dracut Tyngsborough State Forest is approximately one mile north of the Project boundary. The Lowell-Dracut Tyngsborough State Forest spreads across three towns and features over 1,140 acres of protected land, including 180 acres of open water or wetlands and 457 acres of land in the city of Lowell. Popular activities include hiking, fishing, hunting, cycling, birding, picnicking, nature walking, mountain biking, and playing various field sports. In the

winter, people sled, ice skate, and cross-country ski (Commonwealth of Massachusetts 2018b).

Great Brook Farm State Park: Located seven miles south of the Project, this park is a working dairy farm connected to miles of trails that can be used for a variety of recreational activities. The park also includes historic buildings and resources, interpretive programming, and a cross-country ski concession.

Warren H. Manning State Forest: Located five miles south of the Project, this state forest is a largely wooded property with a small recreation area, complete with a spray deck, picnic area, water playground, and fitness trail.

Billerica State Forest: Located six miles south of the Project, this state forest offers rustic, multi-use trails and wooded areas for walking and wildlife viewing.

Carlisle State Forest: Located ten miles south of the Project, this state forest provides over a mile of trails through wooded property protected from forestry activities at the turn of the 20th century. The forest includes an older stand of exceptionally large eastern white pines.

Governor Thomas Dudley State Park: Located ten miles south of the Project, this 11-acre park is a small wooded parcel that provides access to the Concord River and links to other protected open spaces.

At the state level, the focus of outdoor recreation tends to be on recreation lands and facilities outside of urban areas. This is evidenced in the Massachusetts SCORP and MADCR's RMP for the area, which primarily discuss and address recreation in open undeveloped areas like state lands and forests.

Sustainable Lowell 2025 and the 2018 Lowell Open Space and Recreation Plan (OSRP) prepared by City of Lowell, estimates there are 463 acres of open space/recreational land owned or maintained by the city. The City of Lowell reports a variety of recreational amenities including sports facilities (basketball, tennis, softball, swimming, and skateboarding), passive parks for walking, jogging, dog-walking, and picnicking, community gardens, playgrounds, multiuse trails, and greenspaces. City-funded cemeteries provide an additional 222 acres of open space to Lowell residents and visitors (City of Lowell 2018). The City of Lowell has also collaborated with the LNHP to secure funding for and manage the development and redevelopment of 6,662 linear feet of canal walkways throughout Lowell, with work on an additional 11,360 linear feet underway (City of Lowell 2018).

The Concord River Greenway is still in development, but to date has 2,700 linear feet of trail and 1.3 acres of open space cutting through the City of Lowell. Public art and interpretive signs line the multi-modal path. Once complete, the Concord River Greenway will link to a network of trails in the area, including the Bay Circuit Trail, a 200-mile trail from coastal Boston to Kingston, as well as the Bruce Freeman Rail Trail from

Lowell to Framingham. It will also connect Rogers Fort Hill Park and Shedd Park with Lowell Cemetery and the city's cemeteries (City of Lowell 2018).

The attractions in Lowell that are open to the public as part of the LNHP are largely managed by NPS. The LNHP was established in 1978 and is operated by the NPS. It is a primary recreation attraction for the city of Lowell. According to the NPS Visitor Use Statistics website, the LNHP received around 481,536 visitors for the 2019 calendar year (NPS 2020). Opportunities available include museum exhibits, walking tours of the waterways, historic trolly rides, guided tours, music concerts, and boat tours on the Project canals.

The museum exhibits and activities are hands-on, interpretive, and educational opportunities. Key park experiences include the following:

Boott Cotton Mill Museum: Located in the Boott Cotton Mills Museum are interactive exhibits, a weave room, and video programs about the Industrial Revolution, labor, and the rise, fall, and rebirth of Lowell. This complex contains an adapted mill yard and is the most intact surviving example of the first phase of Lowell's mill construction. All four of the original 1835 mills in the Boott mill yard remain as part of an interconnected series of mill buildings.

Mill Girls and Immigrants Exhibit: The Mill Girls and Immigrants Exhibit is a self-guided tour through renovated boardinghouses displaying the kitchen, dining room, and bedrooms furnished in the style of the 1850s. Traditional museum exhibits are located on the second floor, including old photographs, newspaper articles, excerpts from letters, and highlights the lives of specific mill girls and immigrant workers.

Suffolk Mill Turbine Exhibit: This exhibit shows how water from the Western Canal flowed through an opening in the wall of a mill and fell on a large waterwheel in the basement to create kinetic energy. A guided tour also shows one restored turbine using a 13-foot drop of water to rotate shafts, gears, belts, and pulleys to a power loom.

Lowell National Historic Park Canal Walkways Tours: Self or professionally guided recreationists can follow walkways along the network of canals originating at the Pawtucket Dam and ending at the confluence of the Concord and Merrimack Rivers (NPS undated). Most of the walkways that follow the canals are also integrated into the common thoroughfares of the City of Lowell.

The Northern Canal Walkway: The Northern Canal Walkway provides interactive recreation with the historic structures of the Lowell Project, as well as a greenway along a scenic reach of the Merrimack River (NPS undated).

Boat tours led by NPS-guides also provide access to the Project impoundment. The canal boat tours highlight some of the Lowell Project facilities by travelling through the historic navigation locks (NPS undated). Additional recreational opportunities provided by NPS at the LNHP include trolley rides available for touring the city.

5.1.2 Vegetation and Waterborne Trash Management

Pursuant to the approved study plan, Boott reviewed several sources to summarize historical and current practices for vegetation and waterborne trash management in the Project Area.

Following establishment of the LNHP in 1978, MADCR[6], NPS, and Proprietors of the Locks and Canals (Proprietors), entered into an agreement in 1979 regarding management of the Lowell canal system. This agreement establishes MADCR as the lead party responsible for the maintenance of canal structural components, including canal banks and walls. As the lead party, MADCR was responsible for "landscaping and damage repair" to canal banks and walls, with assistance provided by NPS if needed. NPS was charged with the operation of the canal-related exhibits and services, and Proprietors were responsible for the operation and maintenance of the hydroelectric and hydromechanical parts of the Lowell canal system (NPS 1981). NPS developed and issued a Final General Management Plan (FGMP) in August 1981 to provide a basis for visitor use, resource management, and general development within the LNHP. The FGMP states management of the Lowell canal system will be accomplished through cooperative agreements between private and public entities, but MADCR is the lead agency responsible for maintaining, developing, and renovating the major elements of the canal system (NPS 1981).

In 1991, MADCR, the NPS, and Boott executed a Memorandum of Understanding (MOU) for the purpose of maintaining and operating the Lowell Canal System.[7] The MOU assigned specific responsibilities to each party and was filed with the Commission[8] on April 25, 1991 (MOU 1991). Article IV of the MOU directed NPS to assist MADCR in the removal and control of vegetation along the canal system, ("particularly that growing on and in the canal walls") and to assist MADCR in performing ground maintenance. Article IV also directed NPS to assist MADCR in the removal of litter and other waterborne trash from the Lowell Canal System, and states NPS is solely responsible for maintaining and cleaning, ("including removal of trash") all existing trash booms and safety lines/booms on the Lowell Canal System (MOU 1991).

Responsibilities assigned to MADCR under Article V of the MOU include serving as the lead agency for all grounds maintenance, keeping all grass, trees, and shrubs neatly trimmed and in a healthy condition, removing dead or diseased plants, fertilizing, pruning, and thinning of plants (as required), and approving ground maintenance or improvement plans as proposed by NPS. Article V also directs MADCR to assist NPS in

[6] The signatory of the 1979 agreement was the Massachusetts Department of Environmental Management, the predecessor agency to MADCR.

[7] Proprietors of the Locks and Canals on the Merrimack River was included as a party in the MOU but did not execute the agreement.

[8] The 1991 Memorandum of Understanding is available on FERC's eLibrary (https://elibrary.ferc.gov/eLibrary/search) under docket number p-2790.

the removal and control of destructive vegetation along the canal system, and to cooperate with the NPS on developing a litter removal program for waterborne litter and trash on the canals. (MOU 1991). This article also directed MADCR to reimburse NPS for time and materials for work done on the canal system.

Article VI of the MOU directed NPS and MADCR to hold a joint annual meeting to develop an annual destructive vegetation clearing program and canal surface water cleanup program. The annual programs were to be developed in accordance with each agency's budget and seasonal staffing level. Under Article VI, MADCR was also directed to consult with NPS to develop a long-term capital improvement program for the canal system. The minutes of this annual meeting between MADCR and NPS were to be provided to Boott and the Proprietors each year (MOU 1991).

Article IX stated that the MOU would expire five years from the date of signing, with an option for renewal. Efforts to renew the MOU stalled in 1996, as MADCR issued a Grant of Easement[9] to the NPS in late 1995. This Grant of Easement provided NPS rights to implement construction and maintenance improvements at forty-two MADCR-owned parcels around the canal system. Such rights include landscaping, decking, and lighting. The Grant of Easement did not exclusively limit NPS's rights, only stating that construction and maintenance improvements must be consistent with the use of the area as a park. The Grant of Easement did not relinquish MADCR's waterborne trash and vegetation management responsibilities provided by the FGMP or MOU, as described above.

In the RMP for the Lowell/Great Brook Planning Unit, MADCR elaborates the agency was directed by the Commonwealth in 1993 to "concentrate on maximizing the riverfront component and minimizing, but not eliminating, [its] position in the downtown." Under a lower annual budget, MADCR states it has since focused its resources on the riverfront portion of the Lowell Heritage State Park system and less on the downtown canal system (MADCR 2014).

Through the current license term, FERC and Boott have corresponded on vegetation growth and waterborne trash accumulation at facilities within the Project boundary. The FERC Regional Office has regularly inspected the Project pursuant to its dam safety authority under Part 12 of the Commission's regulations. The most recent inspection of the Lowell Project performed on May 14, 2019 found that the facilities were in satisfactory condition, and there were no safety issues observed which required immediate attention. Following the inspection, FERC directed Boott to remove the vegetation and small tree growth observed at the crest of the Great River Wall and on the Hall Street Dam (FERC 2020; FERC 2019). A review of previous inspection reports indicate FERC found the Project facilities to be in overall good condition, and if necessary, directed Boott to remove vegetation growth or waterborne trash observed at Project structures. Boott typically identifies canal structures in need of vegetation removal and control in its Dam Safety Surveillance and Monitoring Reports annually

[9] The 1995 Grant of Easement is also generally referred to as LNHP Deed No. 40.

submitted to the FERC's New York Regional Office, and documents progress made during the preceding year.

Boott annually removes accumulated river-borne debris from the upstream side of the Northern Canal Gatehouse under an MADCR permit. This effort is performed as necessary, typically two to three times annually. Boott also removes debris that accumulates from the upstream side of the Guard Locks and Gatehouse in the Pawtucket Canal on an as necessary basis, both for aesthetics and to ensure that debris does not interfere with the proper functioning of the Guard Gates. Recently, Boott has agreed with the City of Lowell to conduct canal debris removal at recognized accumulation points, many of which are noted in this study.

According to documents and reports filed with the Commission, additional efforts to remove vegetation and waterborne trash from the Lowell canal system of have largely been independent or coordinated efforts between NPS, the City of Lowell, and Boott. In accordance with the MOU, NPS implemented frequent maintenance measures to limit trash accumulation and vegetation growth. On June 18, 2003, NPS filed their 2003 Lock Chamber Operations Manual with FERC. The manual states NPS employees should remove upstream trash in the vicinity of the lock chambers daily, and the lock chambers were to be flushed daily and cleaned of debris (NPS 2003). Operators were instructed to remove trash from in front of the following lock structures: Northern Lock at Pawtucket Gatehouse, Hydro Lock, Swamp Locks, and Francis Gate Lock (NPS 2003).

On October 26-27, 2006, Boott, the NPS, and the City of Lowell collaborated in a major effort to clean-up the canals and walkways The canals were drained for three days before workers from Boott, the City of Lowell, and LNHP could use heavy equipment to remove debris from within the canals. Volunteers also trimmed vegetation and picked up trash along the canal walkways (FERC 2007; Lowell Sun 2006).

After the Study Workshop, NPS provided a copy of their Exotic Species Treatment Calendar (dated September 11, 2018) prepared for the 2019 calendar year. The document presents the reported locations of target exotic vegetation species, methods for management, and an implementation calendar. The target exotic species were primarily reported at upland LNHP-structures outside of the Project boundary (Blacksmith Shop, Kerouac Park, Visitor Center Courtyard, Tremont Street Tracks, Kirk Street Headquarters, and Western Canal Walkway). At Project structures, NPS reported incidents of common invasive species including Garlic mustard (*Alliaria petiolata),* Asiatic bittersweet (*Celastrus orbiculatus*), Tree of Heaven (*Ailanthus altissima),* and Japanese knotweed (*Fallopia japonica*). Treatment methods employed by NPS include mechanical methods of hand-pulling, digging, cutting, seed-heading, mowing, and stump grinding, and chemical methods of foliar spray, herbicidal application to a cut stem/stump, basal bark, stem injection, and hand wicking (LNHP 2018).

There are also community efforts to manage the waterborne trash and vegetation growth. Local nonprofit groups including youth groups, Lowell Canalwaters Cleaners,

Coalition for a Better Acre, and Do-It-Yourself Lowell regularly host cleanup efforts during the warmer seasons.

Boott conducted visual surveys for vegetation growth and waterborne trash locations, and the results are provided below in Sections 5.5 and 5.6.

5.2 Field Inventory

As previously described, Boott conducted a field inventory to document existing non-Project recreation facilities within the Project's vicinity in the fall of 2019. Recreation sites inventoried included the Chelmsford Boat Access, Depot Street Boat Ramp, Greeley Boat Ramp, Lowell Heritage State Park, LNHP, Merrill Park, Merrimack Trail System, Moore's Falls Conservation Area, NPS Canal Walkway, Pawtucket Falls Overlook, and Rourke Brothers Boat Ramp. The Visitor Center (the only-FERC approved recreation facility), was closed on the days of inventory, but the external features (e.g. parking lot) were also inventoried.

Field inventory documentation, including a map of non-Project recreation facilities, representative photographs, and a description of amenities available at each facility is presented as Appendix B to this study report. The field inventory indicates there are considerable opportunities for recreation in the Project area. Most sites inventoried were reported in good condition, with parking lots, ample signage, and educational exhibits.

5.3 Visitor Use Data and Field Reconnaissance

In total, Boott conducted 53 personal interviews/visitor-intercept surveys between May 2019 and October 2019. In accordance with the approved study plan, Boott also collected field reconnaissance data during the personal interviews including estimating the number of vehicles, recreationists, and observed recreational activities. Results from the personal interviews are compiled in Appendix C and field reconnaissance data is summarized in Appendix D to this study report.

The online visitor use survey was made available to the public from June 2019 until June 2020. A total of 96 respondents completed the online survey. Results from the online surveys are compiled in Appendix E to this study report, and respondent zip codes with a representative map are compiled in Appendix F (for both the personal interviews and online surveys).

Of the personal interviews and online recreation surveys completed, the respondents thus far are typically regular visitors who visit three or more times per year (72 percent of personal interviewees and 76 percent of online respondents) and the remaining respondents identified themselves as first-time visitors or infrequent visitors. Personal interviewees travelled an average of 7.3 miles to the recreation area, with a range of 0.1 miles to 3,000 miles. Online respondents stated they travelled on average around 11 miles to the Project area. Most respondents stated they do not stay overnight in the

Project area in accommodations other than their primary residence (96 percent of personal interviewees and 90 percent of online respondents).

The most common recreational activities survey respondents participated in were trail-related activities (walking, dog-walking, hiking, running, or jogging), bank and/or boat fishing, and kayaking. Walking was the most common primary recreation activity. The majority (77 percent) of personal interview respondents rated their overall experience of recreational activities at the Project as “totally acceptable” or “acceptable.” The majority (92 percent) of personal interview respondents rated their overall experience of recreational activities at the Project as “totally acceptable” or “acceptable.”

According to respondents, the most frequently visited recreational facilities in the Project area were the Lowell Heritage State Park, the Rourke Brothers Boat Ramp, Chelmsford Boat Access, Merrimack Trail System, and LNHP-facilities. Participants were asked several questions regarding their general opinions of recreation in the vicinity of the Project, potential issues with the recreation facilities (i.e., crowding, safety), and recommendations for improvements to existing facilities. In general, the participants did not experience much crowding at the recreational facilities, parking issues, or lack of accessibility to the specific recreational facilities. Respondents both in-person and online tended to rate their overall experience at specific recreation facilities as “totally acceptable.” The most common recommendations for recreational enhancements were: (1) bathrooms/porta potty (2) improving/maintaining the existing structures such as the boat ramps, and (3) the addition of trash cans/trash control measures.

Field reconnaissance data obtained during personal interviews indicates the recreation facilities are well-utilized for many different activities. Walking (and dog-walking) and jogging/running were by far the most common activities observed by technicians. Additional common activities included bicycling, boating, picnicking, and fishing. The Merrimack Trail System and the Lowell Heritage State Park were highly utilized for many different recreational opportunities; these are connecting facilities, so it was common for recreationists to visit both. The Rourke Brothers Boat Ramp and the Chelmsford Boat Access were predictably mostly used for boating, but also commonly utilized for walking, dog-walking, fishing, and picnicking. The Chelmsford Boat Access adjoins a series of softball fields, and technicians reported softball tournaments with hundreds of attendees during the summer weekends. At all facilities, technicians generally reported less activity during the early daylight hours, and during rainy, cool times of the day.

5.4 Evaluation of Expanded Recreational Access in Project Canals

NPS and other stakeholders have expressed interest in new, different, and expanded recreational access to and within the Project canals. In accordance with the SPD, Boott consulted with the NPS, the City of Lowell, and other interested stakeholders to discuss various recreational opportunities associated with the Project canals. During the Study Workshop, stakeholders clarified they were looking for specific practical opportunities for

community on-water recreation. Boott and stakeholders' primary concerns were the recreational rights to the canal system and understanding public safety issues associated with providing recreational access in the Project's canal system.

5.4.1 Rights to Recreational Access to Project Canals

Boott reviewed many sources to understand the recreational rights to the Lowell canal system, including the MOU, the 1984 Great Deed between Proprietors and Boott (Proprietors 1984), the 1986 Order of Taking (Commonwealth of Massachusetts 1986), and the 1995 Grant of Easement from the Commonwealth of Massachusetts to the LNHP (Commonwealth 1995). These documents form the basis of the Resources, Ownership, Boundaries, and Land Rights Study to be filed with the Commission by February 25, 2021. The 1984 Great Deed details the sale of portions of the Project from the Proprietors to the current owner (Boott), and provides the metes, bounds, and elevations of all the structures conveyed, as well as associated easements, access and repair rights (Proprietors 1984). The 1986 Order of Taking details the take of properties, rights, and responsibilities from Boott to the Commonwealth, operating through MADCR (Commonwealth 1986). The 1995 Grant of Easement describes the properties and parcels that were leased from the Commonwealth to the NPS and the rights and responsibilities of both parties with respect to those properties and parcels (Commonwealth 1995).

The review of these documents indicates that the 1984 Great Deed conveyed all canals throughout the canal system to Boott, except for the Pawtucket Canal and the Lower Pawtucket Canal. Proprietors instead retained ownership of the Pawtucket Canal and Lower Pawtucket Canal, and granted Boott an easement for the right to operate the structures of these canals, to "install conduits, pipes, and wiring" and the right to maintain, repair, or replace the existing structures (Proprietors 1984).

By letter dated May 14, 1980, MADCR stated that they were currently in the process of negotiating purchase rights to the Lowell canal system which would allow for recreational boating in the canals, stating further that use of the canals and implementation of the boating program were key elements of the Lowell Heritage State Park (Massachusetts Department of Emergency Management [MADEM] 1980). Through the 1986 Order of Taking, MADCR purchased all air rights over the canals, including over the canal walls and dams, and the exclusive right to use water in the entire canal system for recreational, educational, and navigational purposes, unless said purposes interfere with Boott's hydroelectric generation (Commonwealth 1986). Included in the 1986 Order of Taking is a permanent and exclusive easement to MADCR for all canal walls, beds, or bottoms throughout the canal system for purposes consistent with the use of the canal system as a recreational park. These purposes specifically include placement and attachment of docks, wharves, walls, and boat ramps of a temporary or permanent nature (Commonwealth 1986). The 1995 Grant of Easement from MADCR to LNHP did not convey these exclusive recreation rights to LNHP (Commonwealth 1995).

Based on the review of the MOU, the 1984 Great Deed between Proprietors and Boott, the 1986 Order of Taking, and the 1995 Grant of Easement from the Commonwealth of Massachusetts to the LNHP, Boott currently does not have any right to expand recreational opportunities throughout the Lowell canal system. MADCR purchased all recreational rights over all the canals and canal walls (even canals owned by Boott), including exclusive navigational rights such as boating or canoeing. MADCR maintains an exclusive and permanent easement throughout the entire canal system to install access points such as boat ramps, wharves, and docks. Boott and other stakeholders are not permitted to use the canals as recreational resources, as those rights are exclusively held by MADCR. Boott anticipates providing more information on the recreational rights and responsibilities in the Resources, Ownership, Boundaries, and Land Rights Study Report to be filed with FERC by February 25, 2021.

In the RMP for the Lowell/Great Brook Planning Unit, MADCR does reference its recreational rights over the Lowell canal system, but further elaborates the agency was directed in 1993 to minimize its position in the downtown area (MADCR 2014). On August 14, 2018, MADCR filed comments with FERC on the PAD and Scoping Document 1 for the Project. The comments discuss the various MADCR-owned properties, but do not reference their recreational rights to the Lowell canal system (MADCR 2018).

5.4.2 Public Safety of Recreational Access to Project Canals

Boott reviewed relevant safety and security requirements, guidance documents, and study reports, including the Project's approved Public Safety Plan (Boott 2020), FERC's Guidelines for Public Safety at Hydropower Projects (FERC 2011), Recreation Development at Licensed Hydropower Projects (FERC 1996a), and the Security Program for Hydropower Projects (FERC 2016). Boott also reviewed pertinent guidance, design, and planning documents relating to recreational access throughout the canal system.

In accordance with the Commission's approved Public Safety Plan for the Project, Boott maintains fences and gates, lights, sirens, and warning signs to protect the public from the hazards of Project operations (Boott 2020). Boott has historically worked with FERC to strengthen the Public Safety Plan and allow access only where appropriate and safe. As described above, Boott does not have recreational or navigational rights to the canal system. Further, because of the steep canal walls, dams, historic locks and gate structures, and intake/outlet structures associated with the Project, Boott maintains that such access presents an unacceptable risk to public safety and Project security. In the 1990s, incidents of accidental drownings/body recoveries throughout the canal system triggered Boott and FERC to update the Public Safety Plan, install additional warning signs, and fencing to enhance public safety (Boott 1991; FERC 1996b; Boott 1998; Boott 2000).

While Boott does not have recreational or navigational rights to the canal system, Boott believes that providing access would present a number of significant safety concerns. As

an example, FERC's Guidelines for Public Safety at Hydropower Projects states that canals create hazardous conditions due to the steep sides and hard surfaces. The safety guidelines indicate water, algae, and mud make conditions too slick and dangerous for recreationists to escape or be rescued. The multiple dams located throughout the canal system (Swamp Locks Dam, Lower Locks and Dam, Lawrence Dam, Hall Street Dam, Merrimack Dam, Rolling Dam, and Boott Dam) as well as the many gates and lock structures, are all also considered potentially hazardous (Figure 3-2). Such structures can create unexpected dangers as surface waters appear calm, but undercurrents are unpredictable. Powerhouse intake areas throughout the canal system also pose hazards to recreationists as currents can change unexpectedly. Boaters will often want to go over lower dams or explore restricted areas, but this must be discouraged by warning signs and barrier systems. As stated in FERC's guidelines, allowing recreationists access to or near to Project facilities poses significant safety and security risks.

In accordance with the SPD, Boott researched infrastructure enhancement that may be required to provide safe public access to the canal system and how such improvements may affect aesthetic and historic resources. FERC recommends that access points, such as canoe/kayak or boat ramps, should be at least 300 feet away from any structure that may pose a hazard (such as dams, intakes, and gate structures). A system of warning devices such as signs, boat restraining barriers, sirens, and buoys also may need installation at least 300 feet from any hazardous structure. At a minimum, escape devices such as life preservers and safety ropes are recommended to be installed near dams, canals, and any other hazardous structures, although FERC acknowledges theft and vandalism can be an issue with such installations. Permanent escape ladders may be considered (especially for canals) and should be installed every 250 feet on either side, but these devices are "attractive nuisances" and can often exacerbate unsafe conditions. Boaters will need escape ladders or other similar emergency escape points as situations can turn dangerous, such as unexpected lightning storms. Any provision of public access to the canals would necessarily create additional responsibilities for city, state and NPS public safety and law enforcement authorities. Additionally, information on dangerous areas, restrictions on speed, direction, or access (especially in canals), alcohol use restrictions, enforcement and penalties, and other information relevant to safe recreational practice should be provided to recreationists at access points (FERC 2011).

5.4.3 Expansion of Recreational Access to Project Canals

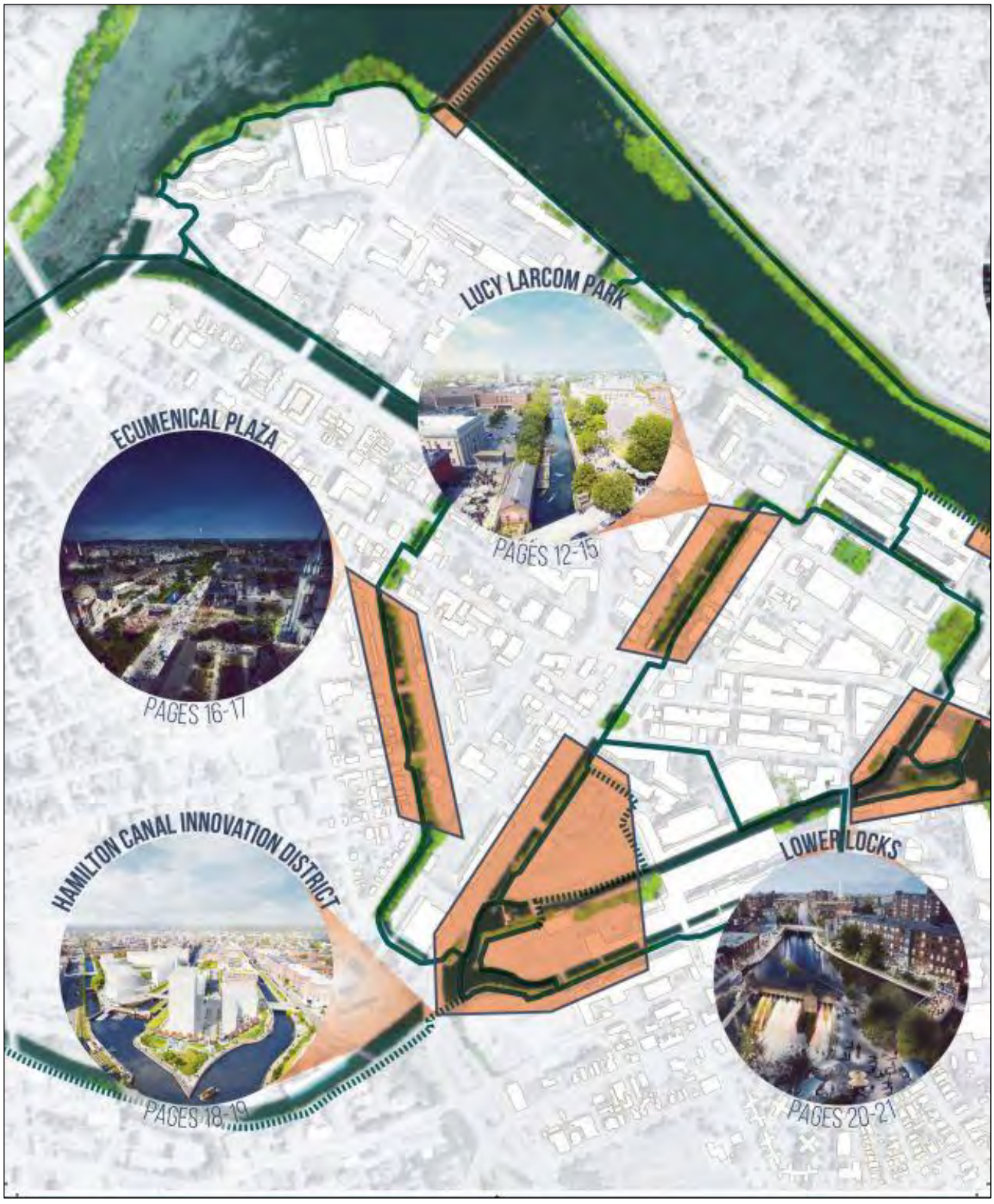
Given the information presented in Section 5.4.1 and 5.4.2, the opportunities for expansion of recreational opportunities in the Project canals are limited. MADCR exclusively owns all rights to allow recreation on or in the Project canals and holds easement rights to install recreational access points. As such, Boott does not have the rights to provide expanded recreational opportunities within the canal system. Surface water recreation in the canals was evaluated by the Lowell Historic Preservation Commission and the LNHP in public planning documents such as the 1977 Brown Book,

the 1981 FGMP, and the 2017 Lowell Waterways Vitality Initiative Action Plan (Action Plan). The LNHP 1990 Preservation Plan Amendment stated:

> "The canals offer few boating opportunities beyond the Park's well-organized tour boat program. Because of swift water, lack of depth and width, low clearances, and other physical restrictions, water recreation is limited. If pleasure boating by individuals is to be considered, it should be kept to the Pawtucket Canal, and allowed mainly as a link to the Merrimack River. Paddle boating is possible if access, safety, and permitting are addressed. The Merrimack Canal at Lucy Larcom Park has been identified as the best place for still water activities such as this. In general, water taxis, dinner boats, and other organized boating program's will be encouraged, subject to permission from the Heritage State Park [MADCR] which controls recreational boating rights on the canals. The Pawtucket and Northern Canals offer possible routes, and could become a feature of the Canalway through private concessions."

The 2017 Action Plan was published as a collaborative report from the City of Lowell, the Lowell Heritage Partnership, and ex-officio members from the LNHP. The report presented consensus from the group on certain water-related areas that offer the best potential. The Action Plan identified the following canal areas: Lucy Larcom Park (Merrimack Canal); Ecumenical Plaza (Western Canal); Lower Locks, and the Hamilton Canal Innovation District (Hamilton, Pawtucket, and Merrimack Canals). The areas identified are shown in Figure 5-2.

Figure 5-2. Water-Based Areas Identified in the 2017 Action Plan

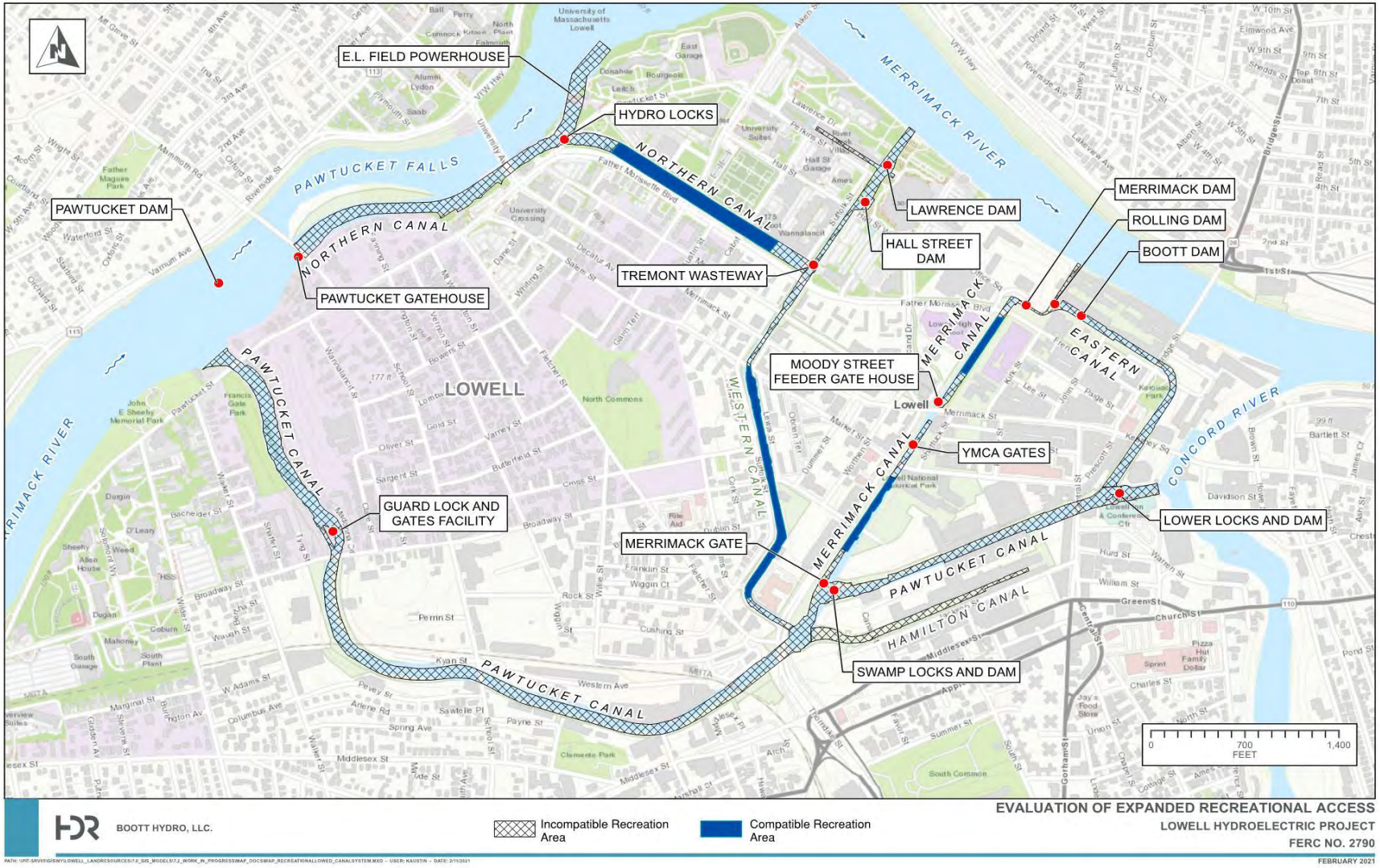


With recreational rights, Project operations and public safety, and prior scoping by stakeholders in mind, Boott has identified specific segments of the canal system as potentially compatible with current Project operations, and those areas are shown below in Figure 5-3. The Merrimack Canal along Lucy Larcom Park is a recreation area potentially compatible with current Project operations. Surface water recreation should be restricted to the area in between the Moody Street Feeder Gatehouse and the Merrimack Dam, at least 300 feet from either structure. This area is acceptable for stillwater activities like paddle boating, as identified in the 1990 Preservation Plan Amendment. The portion of the Merrimack Canal downstream from Merrimack Gate is potentially compatible for similar surface water recreation, and this area was identified in the 2017 Action Plan as a part of the Hamilton Canal Innovation District. The segment of Western Canal along the Ecumenical Plaza area has also been identified as potentially compatible with stillwater recreation. The segment of the Northern Canal between Hydro Locks and Tremont Gatehouse could also be compatible with stillwater recreation. This evaluation does not include the already-established NPS tour boat program.

The remaining portions of canal system, including the remaining portion of the Hamilton Canal Innovation District (Pawtucket Canal, Hamilton Canal, and Swamp Locks) and the Lower Locks area, are not considered compatible with current Project operations, safety, and property rights. These areas may have swift currents and hazardous structures through the canals, including intakes, dams, locks, gate structures, low-clearance bridges, and there were no segments deemed compatible with current Project operations. In accordance with the Public Safety Plan, Swamp Locks and Lower Locks are currently equipped with signage stating, “Beware Water Rises Rapidly.” In addition to being unsafe, Hamilton Canal and the Lower Pawtucket Canal below Swamp Locks are both flanked with tall, renovated mill buildings on either side which severely limit emergency access and the ability to construct safety devices. Notably, Boott does not own the Pawtucket Canal, Swamp Locks, or Lower Locks; these structures remain under the ownership of Proprietors.

Boott notes that the information presented is developed at a conceptual/screening level only for purposes of this report. The feasibility of any potential safety, security, and recreation development activities is subject to additional design, permitting, and other federal, state, and local municipal requirements as may be appropriate. Further, this information is not intended to serve as a proposal by Boott for any Project recreation enhancements and should not be construed as such.

Figure 5-3. Potentially Compatible and Incompatible Recreation Areas



5.5 Evaluation of Water Levels and Flows on Recreational Access

In accordance with the SPD, Boott initiated data collection to better understand effects of the crest gate and water levels and flows on (1) NPS boat tours and (2) access to the Northern Canal Walkway.

5.5.1 NPS Boat Tours

In their request for this evaluation, NPS stated that their tour boats barely pass under the Pawtucket Street Bridge over Pawtucket Canal.[10] With even a 1-foot elevation rise of the Project impoundment, NPS states their boats would be unable to pass under the Pawtucket Street Bridge.

On April 18, 2013, FERC authorized Boott to replace the existing wooden flashboard system on the Project's Pawtucket Dam with a pneumatic crest gate system. FERC approved the amended Crest Gate System Operations Plan on March 30, 2015. The plan describes the operation of the pneumatic crest gate system under normal and high-water operations. Under the amended Crest Gate System Operations Plan, when there is no flow over the spillway and flows in the river are below 8,600 cfs [the combined hydraulic capacity of the E.L. Field Powerhouse (6,600 cfs) and downtown canal system (2,000 cfs)], the elevation of the reservoir would be at the normal pond elevation of 92.2 ft NGVD 29. When Merrimack River flows exceed 8,600 cfs, the Crest Gate System Operations Plan allows for a gradual rise in elevation to ± 93.2 ft NGVD 29 until flows reach approximately 11,850 cfs.[11] Under high flows exceeding 11,850 cfs and reaching 31,600 cfs, the crest gate maintains an elevation of ± 93.2 ft.

On November 20, 2019, NPS filed a consultation letter with FERC and Boott. In the letter, NPS stated that Merrimack River flows must be below 12,500 cfs in order for them to operate boat tours in the Pawtucket Canal, and the operating season for boat tours runs from May 15 to October 15.

Flows from United States Geological Survey (USGS) Gage No. 01099500 *Concord River Below River Meadow Brook*, at Lowell, MA were subtracted from flows at USGS Gage No. 01100000 *Merrimack River Below Concord River at Lowell, MA, MA* to calculate the hydrologic data tabulated in Table 5-2, presenting data at the Project from the past 30 years (water years 1987- 2016).

[10] NPS also stated in their letter they are barely able to pass under Central Street Bridge over the Lower Pawtucket Canal. The crest gate does not affect the elevation of waters of the Lower Pawtucket Canal and thus is not included in this analysis.

[11] 11,850 cfs was determined by adding the hydraulic capacity of the E.L. Field Powerhouse (6,600 cfs), the downtown canal system (2,000 cfs) and the extra spillway flow (3,250 cfs) allowed by the Crest Gate System Operations Plan.

Table 5-2. Lowell Hydroelectric Project Hydrologic Data (1987-2016)

Month	Minimum (cfs)	90% Exceedance (cfs)	Average (cfs)	10% Exceedance (cfs)	Maximum (cfs)
January	916	3,462	7,651	12,834	39,710
February	1,478	3,272	6,813	11,415	39,180
March	1,914	4,508	11,484	21,355	50,220
April	2,765	6,558	17,901	31,178	78,890
May	2,034	4,112	10,749	18,657	88,410
June	874	2,279	6,768	13,286	44,660
July	670	1,325	4,207	9,270	29,820
August	569	1,121	3,526	6,852	30,030
September	460	1,008	3,162	6,025	32,264
October	787	1,676	5,938	12,706	50,150
November	1,345	2,888	7,978	14,747	30,990
December	1,839	3,472	9,141	17,243	34,810
Annual	460	1,723	7,941	17,059	88,410

The Project maintains a normal pond elevation of 92.2 ft NGVD 29 when flows in the Merrimack River are up to 8,600 cfs. According to USGS gage data presented in Table 5-2, average flows during the operating season (May 15 through October 15) for NPS boat tours generally do not exceed 8,600 cfs. May is the only month with an average Merrimack River flow above 8,600 cfs.

As described above, when Merrimack River flows exceed 8,600 cfs, the crest elevation gradually rises to 93.2 ft NGVD 29 until flows reach 11,850 cfs. Ultimately, only between Merrimack River flows of 11,850 cfs and 12,500 cfs (NPS' self-reported limit), are NPS boats supposedly unable to pass under Pawtucket Street Bridge. This is a relatively narrow window, especially since the average flow for the entire operating season never reaches 11,850 cfs, and a 10% chance of exceedance of 11,850 cfs only occurs in May, June, and October. The majority of flows through the Lowell Project are a direct result of the annual hydrologic cycle, much of which is unpredictable and inconsistent. Merrimack River flows high enough to raise the pond elevation 1-foot are seemingly just as likely to rise above NPS' self-reported threshold.

5.5.2 Northern Canal Walkway

The Northern Canal Walkway opens seasonally (May 15 through October 15) when flow rates in the Merrimack River and Northern Canal are lower than 3,500 cfs. This threshold was determined because a study demonstrated that a surge wave above 3,500 cfs in the Northern Canal poses a risk of overtopping the Great River Wall. In 1999, the Licensee completed construction of the Surge Gate, designed to attenuate the surge wave in the canal that occurs during sudden plant shutdown. A test of the Surge Gate revealed that the gate did attenuate the resulting transient wave. However, as reported to FERC, the test indicated when fully opened, the significant volume of discharge through the Surge Gate is hazardous to any persons in the riverbed below or near the gate. FERC directed Boott to design a Public Safety Plan to warn the public of this hazard, which included warning signs, sirens and beacons installed at various locations along and in the Merrimack River (FERC 2000). Accordingly, to be conservative and assure public safety, the 3,500 cfs threshold to open the Northern Canal Walkway remained despite the installation of the Surge Gate.

Boott acknowledges that the 3,500 cfs threshold is strict. However, the Surge Gate must open during a unit trip when Merrimack River flows are over 3,500 cfs, otherwise there is a threat of overtopping the Great River Wall and the Northern Canal Walkway. Conversely, the significant amount of flow that is released through the Surge Gate when opened poses an extreme risk to anyone below on the rocky shore or in the riverbed.

There are no conceivable options for Boott's operational modifications to allow the Northern Canal Walkway to remain open above Merrimack River flows of 3,500 cfs. Lock-out/tag-out procedures to disable the Surge Gate are only acceptable when flows are below 3,500 cfs; a moot option because the Northern Canal Walkway would be open. The Surge Gate is designed to release large volumes of water; there is not an option to lessen the amount of water discharged. NPS, City of Lowell, or MADCR staffing/guarding of the area may mitigate this risk below the Surge Gate, but due to the lack of any emergency access to that area it is not recommended by Boott.

5.6 Visual Survey for Vegetation Growth

In total, 96 Vegetation Polygons (representing 80% of the total survey data collected in the study area) and 24 VPs (representing 20% of the total survey data collected in the study area) were mapped between September 25 and September 27, 2019 (Appendix G; Appendix H). As shown in Table 5-3, the total study area encompassed approximately 44 acres and mapped vegetation on/along canal walls accounted for approximately 5 acres (11%) of the study area[12]. The Pawtucket Canal (19.63 acres; 44% of the total study area), Northern Canal (11.67 acres; 26% of the total study area), and Western Canal

[12] VPs are not included in mapped vegetation acreage calculations because they represent a single point(s) on a canal wall.

(5.51 acres; 13% of the total study area) represent more than 80 percent of the total study area (Table 5-3, Appendix G).

Maps showing the results of the vegetation assessment and mapping within the study area are illustrated in a 21-sheet, 11 by 17-inch vegetation type map set with numbered polygons (e.g., 1, 2) and VPs (e.g., VP1, VP2) for each vegetation polygon and/or VP, respectively in Appendix G. Results from the canal wall vegetation mapping are compiled in Appendix H and field reconnaissance data is summarized in Appendix I to this study report.

Table 5-3. Percent total acreage and mapped vegetation acreage of the six major canals associated with the Lowell Project canal system

Canal	Area (acres)	Percentage (%) of Total Study Area	Mapped Vegetation Area (acres)	Percentage (%) of Total Study Area with Mapped Vegetation
Eastern Canal	4.03	9%	0.93	2%
Hamilton Canal	2.01	5%	0.35	1%
Merrimack Canal	1.40	3%	0.38	1%
Northern Canal	11.67	26%	0.89	2%
Pawtucket Canal	19.63	44%	1.33	3%
Western Canal	5.51	13%	0.90	2%
Total	**44.25**	**100%**	**4.78**	**11%**

Pursuant to the approved study plan, vegetation type assessments were completed in the Pawtucket Canal, Northern Canal, Western Canal, Merrimack Canal, Eastern Canal, and Hamilton Canal. In addition, the shoreline/canal type was characterized by dominant features found in each of the mapped polygons and VPs. Field inventory documentation, including a map identifying each polygon or VP, representative photographs, and a description of the vegetation type observed at each polygon or VP is presented in Appendices G-J to this study report.

5.6.1 Eastern Canal

The vegetation mapping and characterization effort was conducted in the Eastern Canal on September 25, 2019. Sheets 8, 11, 12, and 16 present mapped vegetation types within the Eastern Canal (Appendix G). Additional canal-specific information describing vegetation and shoreline/canal features is provided in Appendix H.

The Eastern Canal study area represents 4.03 acres (approximately 9%) of the total study area (Table 5-3, Appendix G). Three (3) VPs were mapped in the Eastern Canal, representing approximately 13 percent of total mapped VPs in the total study area. At the time of the study, mapped VPs in the Eastern Canal had a dominant vegetation type of

Scrub-Shrub (100% of the total). The dominant shoreline type of mapped VPs within the Eastern Canal is either Block Wall (approximately 33.3% of the total) or Block Wall/Concrete/Stone Wall Mix (approximately 66.7% of the total) (Appendix G, Appendix H, and Appendix I).

Fifteen (15) Vegetation Polygons were mapped in the Eastern Canal, representing approximately 16 percent of total mapped Vegetation Polygons in the total study area (Appendix G, Appendix H, and Appendix I). Vegetation was mapped on 0.93 acres of the Eastern Canal walls, representing approximately 19 percent of the total mapped vegetation area within the total study area and approximately 23 percent of the Eastern Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Eastern Canal had a dominant vegetation type of Mixed (approximately 62% of the total). The dominant shoreline type of mapped Vegetation Polygons within the Eastern Canal is either Block Wall (approximately 80% of the total) or Block Wall/Concrete/Stone Wall Mix (approximately 20%) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Eastern Canal with a dominant shoreline type of Block Wall had a dominant vegetation type of Mixed (0.43 acres; approximately 58% of the total) at the time of the study. Scrub-Shrub (0.17 acres; approximately 23% of the total) and Herbaceous (0.12 acres; approximately 16% of the total) were present in lesser amounts, with Trees (0.02 acres; approximately 3% of the total) being minimal at the time of the study. Mapped Vegetation Polygons within the Eastern Canal with a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Mixed (0.15 acres; approximately 79% of the total) or Trees (0.04 acres; approximately 21% of the total) at the time of the study (Appendix G, Appendix H, and Appendix I).

At the time of the study, no mapped VPs or Vegetation Polygons within the Eastern Canal had a dominant vegetation type of Forested. No mapped VPs or Vegetation Polygons within the Eastern Canal have dominant shoreline types of Concrete, Earthen/Terrestrial Cultural, or Stone Wall. (Appendix G, Appendix H, and Appendix I).

5.6.2 Hamilton Canal

The vegetation mapping and characterization effort was conducted in the Hamilton Canal on September 25, 2019. Sheets 19 and 20 present mapped vegetation types within the Hamilton Canal (Appendix G). Additional canal specific information describing vegetation and shoreline/canal features is provided in Appendices H and I.

The Hamilton Canal study area represents 2.01 acres (approximately 5%) of the total study area (Table 5-3). One (1) VP was mapped in the Hamilton Canal, representing approximately 4 percent of total mapped VPs in the total study area. At the time of the study, the mapped VP in the Hamilton Canal had a dominant vegetation type of Herbaceous (100% of the total). The dominant shoreline type of the mapped VP within the Hamilton Canal is Block Wall/Concrete/Stone Wall Mix (100% of the total) (Appendix G, Appendix H, and Appendix I).

Seven (7) Vegetation Polygons were mapped in the Hamilton Canal, representing approximately 7 percent of total mapped Vegetation Polygons in the total study area. Vegetation was mapped on 0.35 acres of the Hamilton Canal walls, representing approximately 7 percent of the total mapped vegetation area within the total study area and approximately 17 percent of the Hamilton Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Hamilton Canal had a dominant vegetation type of Mixed (approximately 74% of the total). The majority of mapped Vegetation Polygons in the Hamilton Canal have a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix (approximately 83% of the total) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Hamilton Canal with a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Mixed (0.26 acres; approximately 90% of the total), Herbaceous (0.02 acres; approximately 7% of the total), or Trees (0.01 acres; approximately 3% of the total) at the time of the study. Mapped Vegetation Polygons within the Hamilton Canal that had a dominant shoreline type of Block Wall had a dominant vegetation type of Trees (0.03 acres; 50% of the total) or Scrub-Shrub (0.03 acres; 50% of the total) at the time of the study. (Appendix G, Appendix H, and Appendix I)

At the time of the study, no mapped VPs or Vegetation Polygons within the Hamilton Canal had a dominant vegetation type of Forested. No mapped VPs or Vegetation Polygons within the Hamilton Canal have a dominant shoreline type of Concrete, Earthen/Terrestrial Cultural, or Stone Wall (Appendix G, Appendix H, and Appendix I).

5.6.3 Merrimack Canal

The vegetation mapping and characterization effort was conducted in the Merrimack Canal on September 25, 2019. Sheets 11 and 15 present mapped vegetation types within the Merrimack Canal (Appendix G).

The Merrimack Canal study area represents 1.4 acres (approximately 3%) of the total study area (Table 5-3). No VPs were mapped in the Merrimack Canal at the time of the study (Appendix G, Appendix H, and Appendix I).

Nine (9) Vegetation Polygons were mapped in the Merrimack Canal, representing approximately 9 percent of total mapped Vegetation Polygons in the total study area. Vegetation was mapped on 0.38 acres of the Merrimack Canal walls, representing approximately 8 percent of the total mapped vegetation area within the total study area and approximately 27 percent of the Hamilton Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Merrimack Canal had a dominant vegetation type of Herbaceous (approximately 53% of the total). The majority of mapped Vegetation Polygons in the Merrimack Canal have a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix (approximately 54% of the total), followed closely by Block Wall (approximately 46% of the total) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Merrimack Canal with a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Herbaceous (0.15 acres; approximately 75% of the total) or Scrub-Shrub (0.05 acres, approximately 25% of the total) at the time of the study. Mapped Vegetation Polygons within the Merrimack Canal with a dominant shoreline type of Block Wall had a dominant vegetation type of Mixed (0.12 acres; 71% of the total) or Herbaceous (0.05 acres; 29% of the total), at the time of the study. Trees represented less than 1 percent (0.003 acres) of the total mapped vegetation area within the Merrimack Canal study area and were the dominant vegetation type of mapped Vegetation Polygons that have a dominant shoreline type of Concrete. (Appendix G, Appendix H, and Appendix I)

At the time of the study, no mapped Vegetation Polygons within the Merrimack Canal had a dominant vegetation type of Forested. No mapped Vegetation Polygons within the Merrimack Canal have a dominant shoreline type of Earthen/Terrestrial Cultural or Stone Wall (Appendix G, Appendix H, and Appendix I).

5.6.4 Northern Canal

The vegetation mapping and characterization effort was conducted in the Northern Canal on September 26 and 27, 2019. Sheets 2, 3, 5, and 6 present mapped vegetation types within the Northern Canal (Appendix G).

As previously described, the Northern Canal study area represents 11.67 acres (approximately 26%) of the total study (Table 5-3). Eight (8) VPs were mapped in the Northern Canal, representing approximately 33 percent of total mapped VPs in the total study area. At the time of the study, the dominant vegetation type of mapped VPs in the Northern Canal was either Trees (50% of the total) or Scrub-Shrub (50% of the total). The dominant shoreline type of all mapped VPs within the Northern Canal is Block Wall (100% of the total) (Appendix G, Appendix H, and Appendix I)

Thirteen (13) Vegetation Polygons were mapped in the Northern Canal, representing approximately 14 percent of total mapped Vegetation Polygons in the total study area. Vegetation was mapped on 0.89 acres of the Northern Canal walls, representing approximately 19 percent of the total mapped vegetation area within the total study area and approximately 8 percent of the Northern Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Northern Canal had a dominant vegetation type of Mixed (approximately 32% of the total), followed closely by Forested and Herbaceous (each representing 28% of the total). The majority of mapped Vegetation Polygons in the Northern Canal have a dominant shoreline type of Block Wall (approximately 53% of the total) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Northern Canal with a dominant shoreline type of Block Wall had a dominant vegetation type of Forested (0.19 acres; approximately 40% of the total), Mixed (0.16 acres; approximately 34% of the total); Scrub-Shrub (0.08 acres; approximately 17% of the total), Trees (0.03 acres; approximately 6% of the total); or Herbaceous (0.01 acres; approximately 2% of the total) at the time of the study.

Mapped Vegetation Polygons within the Northern Canal with a dominant shoreline type of Bock Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Forested (0.05 acres; 17% of the total) or Herbaceous (0.24 acres; 83% of the total) at the time of the study. Mapped Vegetation Polygons within the Northern Canal with a dominant shoreline type of Earthen/Terrestrial Cultural had a dominant vegetation type of Mixed (0.13 acres; 100% of the total) at the time of the study. (Appendix G, Appendix H, and Appendix I)

At the time of the study, the Northern Canal is the only canal with Forested vegetation observed on the dominant shoreline type of Block Wall. No mapped VPs or Vegetation Polygons within the Northern Canal had a dominant shoreline type of Concrete or Stone Wall (Appendix G).

5.6.5 Pawtucket Canal

The vegetation mapping and characterization effort was conducted on the Pawtucket Canal on September 25 and 26, 2019. An NPS boat was used to collect data in the Pawtucket Canal from the Swamp Locks and Dam to the Merrimack River on September 26, 2019. Additional data was collected for the remainder of the Pawtucket Canal on foot from the shoreline on September 25 and 26, 2019. Sheets 13 and 15 through 21 present mapped vegetation types within the Pawtucket Canal (Appendix G). Additional canal specific information describing vegetation and shoreline/canal features is provided in Appendix H and Appendix I.

As previously described, the Pawtucket Canal study area represents 19.63 acres (approximately 44%) of the total study area (Table 5-3, Appendix G). Eight (8) VPs were mapped in the Pawtucket Canal, representing approximately 33 percent of total mapped VPs in the total study area (Appendix G). At the time of the study, the majority of mapped VPs within the Pawtucket Canal had a dominant vegetation type of Trees (approximately 63% of the total). The majority of mapped VPs within the Pawtucket Canal have a dominant shoreline type of Block Wall (38% of the total), followed closely by Block Wall/Concrete/Stone Wall Mix and Stone Wall (each representing 25% of the total) (Appendix G, Appendix H, and Appendix I).

Thirty-two (32) Vegetation Polygons were mapped in the Pawtucket Canal, representing approximately 33 percent of total mapped Vegetation Polygons in the total study area. Vegetation was mapped on 1.33 acres of the Pawtucket Canal walls, representing approximately 28 percent of the total mapped vegetation area within the total study area and approximately 7 percent of the Pawtucket Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Pawtucket Canal had a dominant vegetation type of Trees (53% of the total). The majority of mapped Vegetation Polygons in the Pawtucket Canal have a dominant shoreline type of Block Wall (approximately 85% of the total) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Pawtucket Canal with a dominant shoreline type of Block Wall had a dominant vegetation type of Trees (0.61 acres; approximately 54% of

the total), Mixed (0.42 acres; 37% of the total), Scrub-Shrub (0.08 acres; 8% of the total), or Herbaceous (0.01 acres; 1% of the total) at the time of the study. The majority of mapped Vegetation Polygons within the Pawtucket Canal with a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Scrub-Shrub (0.03 acres; 34% of the total) at the time of the study. Mapped Vegetation Polygons within the Pawtucket Canal with a dominant shoreline type of Concrete had a dominant vegetation type of either Mixed (0.04 acres; 50% of the total) or Trees (0.04 acres; 50% of the total) at the time of the study and mapped Vegetation Polygons within the Pawtucket Canal with a dominant shoreline type of Stone Wall had a dominant vegetation type of Trees (0.03 acres; 100% of the total) at the time of the study. (Appendix G, Appendix H, and Appendix I).

At the time of the study, no mapped VPs or Vegetation Polygons within the Pawtucket Canal had a dominant vegetation type of Forested. No mapped VPs or Vegetation Polygons within the Pawtucket Canal have a dominant shoreline type of Earthen/Terrestrial Cultural. The Pawtucket Canal is the only canal in the total study area that had vegetation mapped on the dominant shoreline type of Stone Wall (Appendix G, Appendix H, and Appendix I).

It should be noted, based on the elevation of the water within the Pawtucket Canal at the time of the investigation, that the majority of the upstream extent of the Pawtucket Canal, upstream of the NPS Guard Lock and Gates Facility, is dominated by typical forested/riparian vegetation on earthen stream embankments and the canal in this area is assumed to not be bordered by one of the shoreline/canal types described in Table 4-2, therefore, no mapping of dominant vegetation types occurred in this area.

5.6.6 Western Canal

The vegetation mapping and characterization effort was conducted in the Western Canal on September 25 and 26, 2019. Mapbook sheets 6, 7, 10, 14, and 19 present mapped vegetation types within the Western Canal (Appendix G). Additional canal specific information describing vegetation and shoreline/canal features is provided in Appendix H and Appendix I.

As previously described, the Western Canal study area represents 5.51 acres (13%) of the total study area (Table 5-3, Appendix G). Four (4) VPs were mapped in the Western Canal, representing approximately 17 percent of total mapped VPs in the total study area. At the time of the study, the majority of mapped VPs in the Western Canal had a dominant vegetation type of Scrub-Shrub (approximately 50% of the total). Mapped VPs in the Western Canal have a dominant shoreline type of either Block Wall (75% of the total) or Block Wall/Concrete/Stone Wall Mix (Appendix G, Appendix H, and Appendix I).

Twenty (20) Vegetation Polygons were mapped in the Western Canal, representing approximately 21 percent of total mapped Vegetation Polygons in the total study area. Vegetation was mapped on 0.9 acres of the Western Canal walls, representing approximately 19 percent of the total mapped vegetation area within the total study area

and approximately 16 percent of the Western Canal study area. At the time of the study, the majority of mapped Vegetation Polygons in the Western Canal had a dominant vegetation type of Forested (approximately 53% of the total). The majority of mapped Vegetation Polygons in the Western Canal have a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix (approximately 77% of the total) (Appendix G, Appendix H, and Appendix I).

Mapped Vegetation Polygons within the Western Canal with a dominant shoreline type of Block Wall/Concrete/Stone Wall Mix had a dominant vegetation type of Forested (0.48 acres; 62% of the total), Mixed (0.16 acres; approximately 21% of the total), or Herbaceous (0.05 acres; 6% of the total) at the time of the study. Mapped Vegetation Polygons within the Western Canal with a dominant shoreline type of Block Wall had a dominant vegetation type of Mixed (0.01 acres; 8% of the total); Herbaceous (0.09 acres; 75% of the total); or Scrub-Shrub (0.02 acres; 17% of the total) at the time of the study. No mapped Vegetation Polygons within the Western Canal had dominant shoreline type of Concrete, Earthen/Terrestrial Cultural, or Stone Wall (Appendix G, Appendix H, and Appendix I).

5.7 Visual Survey for Waterborne Trash

Pursuant to the RSP, on April 9, 2020, Boott mapped areas within the canal system owned or under the control of Boott where waterborne trash may be a potential concern. The amount and type of waterborne trash that accumulates within the Project Boundary can vary according to several factors including the season, Project operations, the magnitude and duration of the flow events. During the visual survey for waterborne trash, the USGS Gage 01100000 Merrimack River BL Concord River at Lowell, MA, reported a discharge of over approximately 16,000 cubic feet per second (cfs) (USGS 2020), and Boott's operations data reported an inflow of 14,500 cfs.[13]

Accumulated waterborne trash includes material floating on the impoundment surface and/or found on the surface of the canal system. Most of the waterborne trash accumulation within the Lowell Canal system appears to be derived from upstream inputs (the Merrimack River) as well as direct canal inputs (accidental and intentional littering) and from runoff events (also likely from accidental and intentional littering).

In total, eight (8) areas of waterborne trash totaling 0.21 acres (representing 0.48% of the total study area) were mapped on April 9, 2020 (Appendix K) as well as three additional areas of accumulated trash on the canal bed and a single area with a waterborne sheen. The total study area encompassed approximately 44 acres and as shown in Table 5-3 all mapped areas within the canal were 3.531 acres or approximately 154,000 square feet.

[13] Inflow to the project is typically estimated as flow reported at USGS Gage 01100000 Merrimack River BL Concord River at Lowell, MA minus the flow reported at USGS 01099500 Concord River Below Meadow Brook, at Lowell, MA.

Maps showing the results of the waterborne trash assessment and mapping within the study area are illustrated by a map set with numbered polygons (e.g., WBT-1, WBT-2) for each mapped waterborne trash polygon (Appendix K). Results from the waterborne trash mapping are compiled in Appendix K and field reconnaissance data is summarized in Table 5-3 and Photo 5-2 through Photo 5-11.

Table 5-4. Percent total acreage of waterborne trash mapped within the Lowell canal system.

Mapped Polygon Identifier	Location	Mapped Area (acres)	Mapped Area (sq. ft.)	Canal Water Level	Potential Local Cause
WBT-1	Merrimack River at Fishway Exit	0.007	286.0	High	Eddy Area at head of fishway
WBT-2	Merrimack River Upstream of Pawtucket Gatehouse	0.063	2,765.0	High	Gatehouse
WBT-3	Western Canal at Merrimack Street	0.011	488.0	Normal	Iron support beams for bridge
WBT-4	Western Canal at Moody Street	0.038	1,674.0	Normal	Gate
WBT-5	Northern Canal and Western Canal Junction	0.013	545.0	Normal	Fremont Gatehouse, structure creating eddy
WBT-6	Merrimack Canal at Market Street	0.024	1,045.0	Normal	Gates
WBT-7	Pawtucket Canal at Guard Locks	0.049	2,120.0	Normal	Gatehouse
WBT-8	Hamilton Canal adjacent to Hamilton Mills	0.004	182.0	Normal	End of Canal (Intake)
CBT-1	Pawtucket Canal from Industrial Canyon to Kerouac Park	1.833	79,832.0	Low	Canal dewatered
CBT-2	Pawtucket Canal adjacent to Appleton Mills	0.537	23,411.0	Low	Canal dewatered
CBT-3	Eastern Canal adjacent to Tsongas and Boarding House Park	0.468	20,395.0	Low	Canal dewatered
WBS-1	Merrimack Canal adjacent to Visitor Center	0.484	21,066.0	Normal	Unknown sheen
	Total	**3.531**	**153,809.0**	**-**	**-**

Pursuant to the approved study plan, waterborne trash assessments were completed in the Pawtucket Canal, Northern Canal, Western Canal, Merrimack Canal, Eastern Canal, Hamilton Canal, and in the Merrimack River upstream of the dam and Northern Canal intake. Field inventory documentation, including a map identifying each polygon and a description of the type of waterborne trash observed at each polygon is presented in Appendix K to this study report.

Boott surveyed the Lowell canal system on foot and by vehicle to visually inspect and document waterborne trash within the study area. Observations were recorded regarding evidence and location of waterborne trash. Data collected during this portion of the survey included field notes, digitized locations of waterborne trash, and photographic documentation.

In addition to mapping waterborne trash, during incidental observations for other field efforts, Boott observed aged substrate trash accumulation in the bottom of the Eastern Canal and portions of the Pawtucket Canal during dewatered for various construction and maintenance activities not associated with hydroelectric operations. This aged substrate trash is further described in Section 5.6.9 below and is also depicted on the map of the study area in Appendix K.

Boott also observed a surface sheen on the Merrimack Canal on April 9, 2020. This sheen is further described in Section 5.6.10 below and is also depicted on the map of the study area in Appendix K.

5.7.1 Merrimack River at the Fishway Exit

Waterborne trash observed on the Merrimack River fishway exit (WBT-1) encompassed a water surface area of approximately 0.007 acres (Table 5-3). This trash appears to accumulate in an eddy type feature and above the intake water for the fishway. Waterborne trash consisted of buoys, plastics, shoes, rubber mats, foam, and bait containers (No photo available).

5.7.2 Merrimack River Upstream of the Pawtucket Gatehouse

Waterborne trash observed on the Merrimack River upstream of the Pawtucket Gatehouse (WBT-2) encompassed a water surface area of approximately 0.063 acres (Table 5-3). This trash appears to accumulate in an eddy type feature and above the gatehouse intakes. Waterborne trash consisted of logs, boards, organic debris, plastic cups, plates, shoes, water bottles, buoys, plastics, foam, and bait containers (Photo 5-1).

Photo 5-1. Waterborne trash on the Merrimack River upstream of the Northern Canal Gate entrance.

5.7.3 Western Canal at Merrimack Street

Waterborne trash observed on the Western Canal at Merrimack Street (WBT-3) encompassed a water surface area of approximately 0.011 acres (Table 5-3). This trash appears to be behind steel beams across the canal, potentially for structural support of the road bridge for Merrimack Street. Waterborne trash consisted of foam plates, plastic cups, rubber balls plastic jugs, plastic wrappers and bags (Photo 5-2).

Photo 5-2. Waterborne trash on the Western Canal at Merrimack Street.

5.7.4 Western Canal at Moody Street

Waterborne trash observed on the Western Canal at Moody Street (WBT-4) encompassed a water surface area of approximately 0.038 acres (Table 5-3). This trash appears to accumulate behind an operable gate structure. Waterborne trash consisted of tires, umbrellas, foam plates, plastic cups, plastic bottles, rubber balls, plastic jugs, plastic wrappers, foam boards and bags (Photo 5-3).

Photo 5-3. Waterborne trash on the Western Canal at Moody Street.

5.7.5 Northern Canal and Western Canal Junction at the Tremont Gatehouse and Powerhouse

Waterborne trash observed on the Northern Canal and Western Canal junction at the Tremont Gatehouse and Powerhouse (WBT-5) encompassed a water surface area of approximately 0.013 acres (Table 5-3). This trash appears to accumulate in an eddy within a large indent within the canal wall structure located just upstream of the Fremont Gatehouse. Waterborne trash consisted of foam board pieces, plastic cups, foam plates, foam bait containers, shoes, plastic bottles, and organic debris (Photo 5-4).

Photo 5-4. Waterborne trash on the Western Canal at the Northern Canal Junction.

5.7.6 Merrimack Canal at Market Street

Waterborne trash observed on the Merrimack Canal at Market Street (WBT-6) encompassed a water surface area of approximately 0.024 acres (Table 5-3). This trash appears to accumulate behind the operational gates at this location. Waterborne trash consisted of plastic bottles, foam containers, foam cups, plastic bags, rubber balls, diapers, glass bottles, wood, plastic wrappers, soft drink cans, and organic debris (Photo 5-5).

Photo 5-5. Waterborne trash on the Merrimack Canal at Market Street.

5.7.7 Pawtucket Canal at the Guard Lock and Gate Facility

Waterborne trash observed on the Pawtucket Canal at the Guard Lock and Gate Facility (WBT-7) encompassed a water surface area of approximately 0.049 acres (Table 5-3). This trash appears to accumulate upstream of the Guard Lock water release structure on river left. Waterborne trash consisted of paper, foam boards, all types of balls (rubber, plastic, baseball, soccer, etc.), organic matter, logs, tires, construction barrels, plastic bottles, cans, foam containers (Photo 5-6).

5.7.8 Hamilton Canal Adjacent to Hamilton Mills

Waterborne trash observed at the end of Hamilton Canal at the intake (WBT-8) encompassed a water surface area of approximately 0.004 acres (Table 5-3). This trash appears to accumulate at the intake (No photo available).

Photo 5-6. Waterborne trash on the Pawtucket Canal at Guard Lock and Gate Facility.

5.7.9 Observations of Aged Substrate Trash Accumulation on the bottom of the Eastern Canal and Portions of the Bottom of the Pawtucket Canal

Observations of substrate trash accumulation on the bottom of the Eastern Canal and portions of the Pawtucket Canal occurred during a dewatering event associated with non-Project construction and maintenance activities. This substrate accumulation encompassed an area of approximately 0.468 acres (Table 5-3) in the Eastern Canal, approximately 1.833 acres in the Pawtucket Canal near “Industrial Canyon”, and 0.537 acres in the Pawtucket Canal immediately downstream of the Swamp Locks. The substrate trash in the Eastern Canal consist largely of iron, traffic cones, cans, and woody debris. In the Pawtucket Canal near Industrial Canyon, the substrate trash consists mostly of wood, iron, and plastic trash. The Pawtucket Canal downstream of Swamp Locks consists mostly of metal and some minimal floating plastic bottles (Photo 5-7 through Photo 5-10).

Photo 5-7. Substrate trash on bottom of Eastern Canal across from Boarding House Park.

Photo 5-8. Substrate trash on bottom of Eastern Canal across from Boott Cotton Mills Museum and Tsongas Industrial History Center.

Photo 5-9. Substrate debris at the bottom of Pawtucket Canal adjacent to Appleton Mills and downstream of Swamp Locks.

Photo 5-10. Waterborne trash immediately downstream of Swamp Locks.

5.7.10 Observations of Surface Sheen

Boott also observed a surface sheen on the Merrimack Canal on April 9, 2020. The location of the source of this sheen was undetermined but appear to begin at or upstream of the Swamp Locks (Photo 5-11).

Photo 5-11. Surface sheen observed on April 9, 2020 on Merrimack Canal adjacent to the Visitor Center and downstream of the Swamp Locks.

6 Summary and Discussion

6.1 Field Inventory and Visitor Use Data

The results from the field inventory and the visitor use data (personal interviews, field reconnaissance, and online surveys) are consistent with the literature review. The field inventory identified extensive recreational facilities in the Project area, with the available amenities reported in good condition. Of the fifty-three (53) personal interviews and ninety-six (96) online recreation surveys completed, the respondents are typically regular visitors who visit three or more times per year. Respondents travelled an average of 7.3 miles (personal interviews) and 11 miles (online survey respondents) to the Project area. The most reported recreational activities are light activities such as walking, dog walking, and jogging, with most respondents rating their overall experience of recreational activities at the Project as “acceptable” or “totally acceptable.” The most frequently visited recreational facilities in the Project area were the Lowell Heritage State Park, the Rourke Brothers Boat Ramp, Chelmsford Boat Access, Merrimack Trail System, and LNHP-related facilities. Respondents both in-person and online tended to rate their overall experience at these specific recreation facilities as “acceptable” or “totally acceptable.”

6.2 Evaluation of Recreational Access

The opportunities for expansion of recreational opportunities in the Project canals are limited. MADCR exclusively owns all rights to allow recreation on or in the Project canals and holds easement rights to install recreational access points. However, Boott identified segments of the Merrimack Canal, Western Canal, and Northern Canal as surface water recreation areas potentially compatible with existing Project operations, safety, and recreational and property rights.

Boott also evaluated the effects of water levels and flows and crest gate operations on NPS-boat tours and the Northern Canal Walkway access. Between flows of 11,850 cfs and 12,500 cfs (NPS' self-reported limit), NPS boats are reportedly unable to pass under Pawtucket Street Bridge. This is a relatively narrow difference, and such high flows are not common during the operating season (May 15 to October 15).

Boott also researched the 3,500 cfs threshold to open the Northern Canal Walkway. While the Surge Gate was installed to mitigate the risk of overtopping of the Great River Wall, the volume of water released from the Surge Gate is considered dangerous to any persons below on the riverbed or bank.

6.3 Visual Survey for Vegetation Growth

A wide variety of vegetation types, occurrences, and distribution, ranging from herbaceous, non-woody plants to forested areas of trees and underbrush, and shoreline/canal types, ranging from earthen embankments to placed, uniformly sized blocks, were observed during the canal wall vegetation surveys. The following summary statements are based on an analysis of survey results (Appendix G-Appendix I):

- Mapped vegetation[14] was greatest in the Pawtucket Canal (1.33 acres; approximately 28% of the total study area), followed by the Eastern Canal (0.93 acres), Western Canal (0.90 acres), and Northern Canal (0.89 acres) (each representing approximately 19% of the total study area).
- At the time of the study, most mapped VPs within the total study area had a dominant vegetation type of Scrub-Shrub (46% of the total VP count), followed closely by Trees (38% of the total VP count). The majority of mapped Vegetation Polygons within the total study area had a dominant vegetation type of Mixed (41% of the total mapped vegetation area) at the time of the study.
- Within the total study area, most mapped VPs had a dominant shoreline type of Block Wall (63% of the total VP count). The majority of mapped Vegetation Polygons within the total study area also had a dominant shoreline type of Block Wall (58% of the total mapped vegetation area).

[14] VPs are not included in mapped vegetation acreage calculations because they represent a single point(s) on a canal wall.

- Mapped Vegetation Polygons with a dominant vegetation type of Forested were only recorded within the Western Canal (53% of the Western Canal study area), and the Northern Canal (28% of the Northern Canal study area) at the time of the study. Forested vegetation was recorded on Block Wall (0.19 acres; approximately 4% of total mapped vegetation area) and Block/Wall/Concrete Stone Wall Mix (0.53 acres; approximately 11% of the total mapped vegetation area) at the time of the study.

6.4 Visual Survey for Waterborne Trash

The surveys for waterborne trash have shown that waterborne trash accumulates within the Project's canal system, and these accumulations are somewhat dependent on the level of the water within the canals as well as the required operation of some of the NPS gates within the study area. For example, NPS gates that are operated on a routine basis had minimal signs of waterborne trash associated with them, while others that are largely in the closed position tended to have accumulations of waterborne trash behind them at varying densities.

The combination of past and present land use activities in and around the Project area have contributed and will likely continue to contribute to the accumulation of waterborne trash within the Project's canal system that occur in the study area today (e.g., industrialization, commercial development, residential areas in close proximity to canals, etc.). However, the complexity and diversity of historical and current land use activities in the study area create a problem for tracing and identifying the sources of waterborne trash and its movement and distribution within the study area. Waterborne trash consisted of common materials such as foam board pieces, plastic cups, foam plates, foam bait containers, shoes, plastic bottles, and organic debris.

It is well known that many types of land uses contribute to the accumulations of waterborne trash including stormwater drainage systems, upstream sources, inappropriately discarded trash, natural events (woody debris), densely populated areas, etc. Roads, construction, recreation, residential developments, and commercial and industrial developments all can contribute to the problem. Ongoing Project operation and maintenance has very little potential to cause and/or significantly contribute to the waterborne trash accumulation areas observed during the study.

7 Variances from FERC-Approved Study Plan

The Recreation and Aesthetics Study was conducted in full accordance with the methods described in the FERC-approved study plan except for the following variances:

- When conducting personal interviews at the recreation facilities identified in consultation with stakeholders, field technicians generally attempted to visit each of the selected recreation facilities during every survey event. In some instances, field technicians encountered conditions at recreation facilities that presented safety risks. In such instances, field technicians avoided those facilities during the survey event

and documented the unsafe conditions encountered that prevented personal interviews from occurring.

- When conducting canal wall vegetation surveys within/along the six canals identified, field technicians generally attempted to survey the entirety of the canal study area. In some instances, field technicians encountered conditions within/along the canals that restricted access for surveying. In such instances, field technicians advanced within/along the canal wall to the extent practicable and assessed vegetation from a distance collecting photo documentation.
- During the evaluation of expanded recreational access to the canal system, Boott did not generate cost estimates to develop recreational access to the Lowell canal system, as proposed in the RSP. Boott did not develop these cost estimates because Boott does not have any rights to develop recreational access to the Lowell canal system.

8 Germane Consultation and Correspondence

A summary of germane correspondence and consultation related to the Recreation and Aesthetics Study is presented in Table 8-1. Appendix L provides copies of relevant correspondence.

Table 8-1. Germane Consultation and Correspondence

Date	Type	From	To	Subject
May 7, 2019	Email/Letter	HDR and Boott	NPS, American Whitewater, and MADCR	Consultation on locations for visitor-intercept/personal interview locations
May 17, 2019	Letter	American Whitewater	HDR and Boott	Consultation on locations for visitor-intercept/personal interview locations
June 3, 2019	Email	HDR	NPS	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
June 4, 2019	Email	NPS	HDR	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
June 12, 2019	Email	NPS	HDR	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
June 12, 2019	Email	HDR	NPS	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
June 14, 2019	Email	HDR	NPS	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
July 2, 2020	Email	HDR	NPS	Lowell Recreation and Aesthetics Study
July 3, 2020	Email	NPS	HDR	Lowell Recreation and Aesthetics Study
October 1, 2019 (Accession Number 20191001-5038)	Letter	NPS	FERC, Boott, HDR	Comments on Study Process and the Recreation and Aesthetics Study
November 1, 2019	Email	HDR and Boott	NPS, MADCR, City of Lowell, Lowell Parks and Conservation Trust	Study Workshop Planning
November 1, 2019	Email	NPS	HDR	Study Workshop Planning
November 4, 2019	Email	City of Lowell	HDR	Study Workshop Planning
November 8, 2019	Email	HDR and Boott	NPS, MADCR, City of Lowell, Lowell Parks and Conservation Trust	Study Workshop Planning

Date	Type	From	To	Subject
December 9, 2019	Email	HDR and Boott	NPS, MADCR, City of Lowell, Lowell Parks and Conservation Trust	Study Workshop Planning
December 19, 2019	Email	NPS	HDR	Vegetation Mapping Consultation
December 20, 2019	Email	MADCR	HDR	Lowell Recreation and Aesthetics Study
December 20, 2019	Email	HDR	MADCR	Lowell Recreation and Aesthetics Study
March 13, 2020	Email	HDR	NPS	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
March 13, 2020	Email	NPS	HDR	Schedule regarding trash mapping activities for the Lowell Recreation and Aesthetics Study
April 10, 2020 (Accession Number 20200410-5033)	Email	NPS	HDR	Comments on the Recreation and Aesthetics Study
April 22, 2020 (Accession Number 20200422-5027)	Letter	American Whitewater	FERC, Boott, HDR	Comments on the Recreation and Aesthetics Study

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Appendix A - Recreation Interview and Survey Forms

Personal Interview Survey Form

ON-SITE/IN-PERSON RECREATION INTERVIEW
Lowell Project (FERC No. 2790)
Recreation Survey

Boott Hydropower, LLC (Boott), a subsidiary of Enel Green Power North America, Inc., owns and operates the Lowell Project, which is licensed by the Federal Energy Regulatory Commission (FERC). The current operating license for the Project was issued on May 1, 1973 and expires on April 30, 2023. Boott will file its application with FERC for a new license for continued project operation no later than April 30, 2021. As part of this relicensing process, Boott is conducting a series of resource studies to enable FERC to prepare its environmental review document and develop a new operating license. The purpose of this survey is to gather information regarding participation in outdoor recreation activities at the Lowell Project.

Interview Location:			
Home Zip Code:	_____	**Date:**	_____
Age:	_____	**Time:**	_____
River Conditions:			_____
Are you:	**Male** ☐	**Female** ☐	**Prefer not to answer** ☐
Interviewer:			

Q-1. Regarding the Lowell Project area, do you consider yourself: (**Please circle one)**

1. A regular visitor to this area (*3 or more times per year*)
2. An occasional visitor (*1-2 times per year*)
3. An infrequent visitor (*Less than 1 time per year*)
4. This is my first visit

Q-2. On this trip to the Lowell Project area, when did you arrive?

Arrival Date **Arrival Time**

_____/_____/_____ _____AM/PM

When did you or do you expect to leave the Lowell Project area?

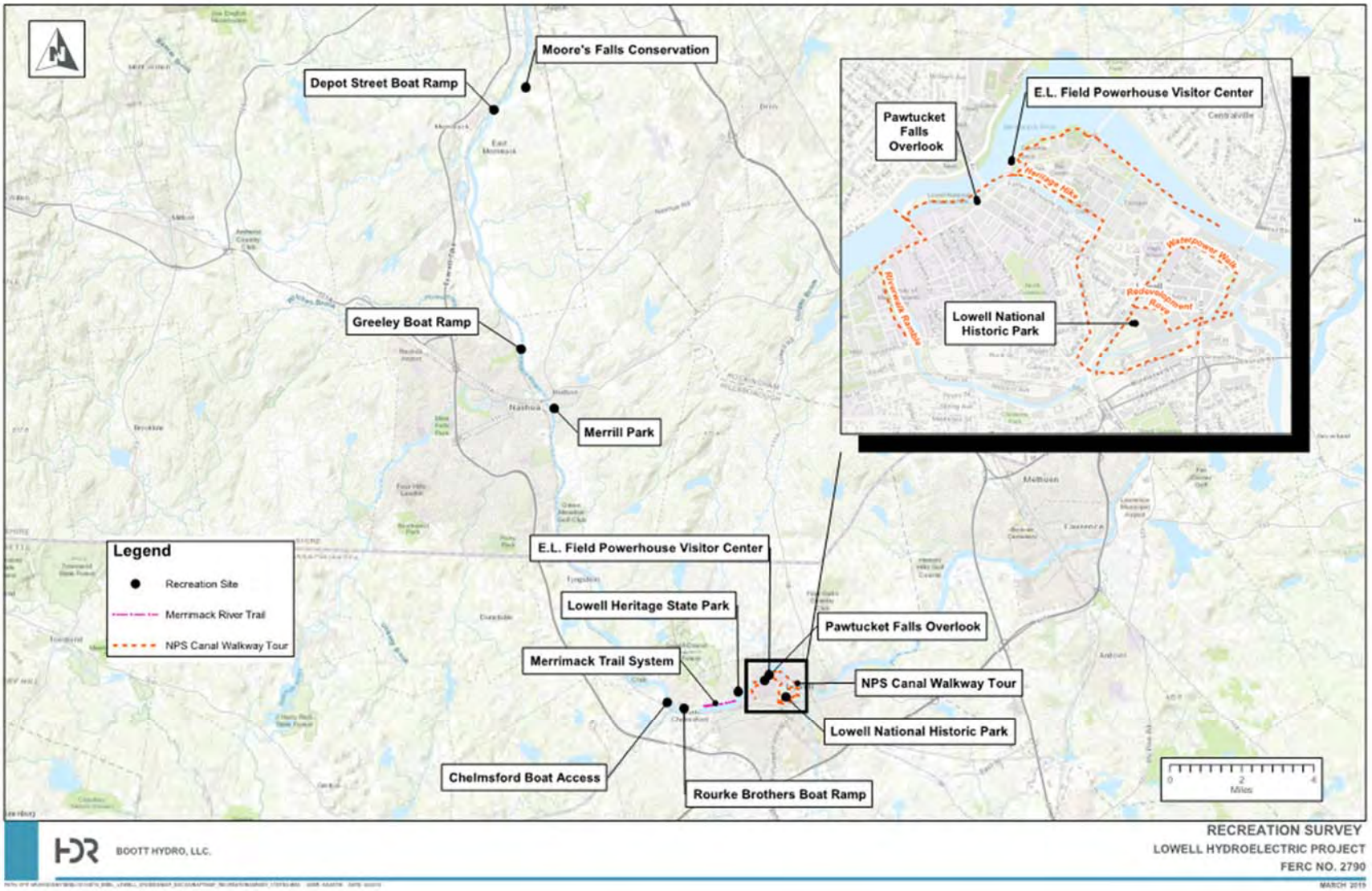
Departure Date **Departure Time**

_____/_____/_____ _____AM/PM

Q-3. During the last 12 months (including this trip), which month(s) did you visit the Lowell Project area?

A. _____

Project Area Recreation Map



Q-4. Which of the following recreation areas at or near the Lowell Project did you utilize for recreation during the past 12 months? **(Please circle all that apply)**

1. Lowell Heritage State Park
2. Merrimack River Trail
3. E.L. Field Powerhouse Visitor Center
4. NPS Walkway Tours
5. Riverwalk Ramble
6. Waterpower Walk
7. Heritage Hike
8. Northern Canal Walkway
9. Redevelopment Rove
10. Boat access facilities on the Project impoundment
11. Lowell Heritage State Park – Rourke Brothers Boat Ramp
12. Pawtucket Falls Overlook (Lowell, MA)
13. Chelmsford Boat Access (Chelmsford, MA)
14. Merrill Park (Hudson, NH)
15. Greeley Boat Ramp (Nashua, NH)
16. Depot St. Boat Ramp (Merrimack, NH)
17. Moore's Falls Conservation Area (Litchfield, NH)
18. Informal Shoreline Parking/Access Areas
19. None of the above
20. Other (Please list)

_____
_____
_____

Q-5. On your last trip, about how many miles did you travel to get to the Lowell Project?

A. _____miles

Q-6. Are you staying overnight in the Lowell Project area (not including at your own home) on this trip?

1. Yes 2. No

Q-7. If you answered yes to **Q-6**, at what type of accommodations will you be staying? (**Please circle one)**

1. RV/Auto/Tent Campground
2. Motel/hotel
3. Bed and Breakfast
4. Vacation or rental home
5. Other (Please specify: _____)

Q-8. How many people (including you) are in your group?

A. _____people

Q-9. Which of the following best describes your group during this trip?

1. Individual
2. Adult group (over 21)
3. Youth group (under 21)
4. Family (with children)
5. Mixed group (groups with children, adults, and/or teens)

Q-10. On this trip to the Lowell Project area, in which of the following activities have you or do you expect to participate? (**Please circle all that apply**)

1. Bank fishing	12. Canoeing	24. RV camping
2. Boat fishing	13. Kayaking	25. Tent camping
3. Guided fishing experience	14. Commercial whitewater boating	26. Photography
4. Walking tour	15. Museum-going	27. Sightseeing
5. Hiking	16. Shopping and/or dining	28. Relaxing
6. Backpacking	17. Swimming	29. Sunbathing
7. Guided canal tours	18. Off-highway vehicle (dirt bike/ATV)	30. Dog walking
8. Historical/heritage site visiting	19. Horseback riding	31. Painting/drawing
9. Running, jogging, and fitness	20. Off-road mountain biking	32. Other (please describe):
10. Rock climbing/bouldering	21. Road cycling	
11. Picnicking	22. Adventure sports	
	23. Geo-caching	

Q-11. Of the activities you circled in **Q-10** above, what is the primary activity that you participated in, or expect to participate in, on this visit? (**Please write in the corresponding number from above**)

A. Primary activity # _____

Q-12. Please rate the following for the primary activity you chose above:

	Totally Unacceptable	**Unacceptable**	**Neutral**	**Acceptable**	**Totally Acceptable**
Challenge	1	2	3	4	5

Safety	1	2	3	4	5
Enjoyment	1	2	3	4	5
River/Canal Flow	1	2	3	4	5
Crowding	1	2	3	4	5
Overall Experience	1	2	3	4	5

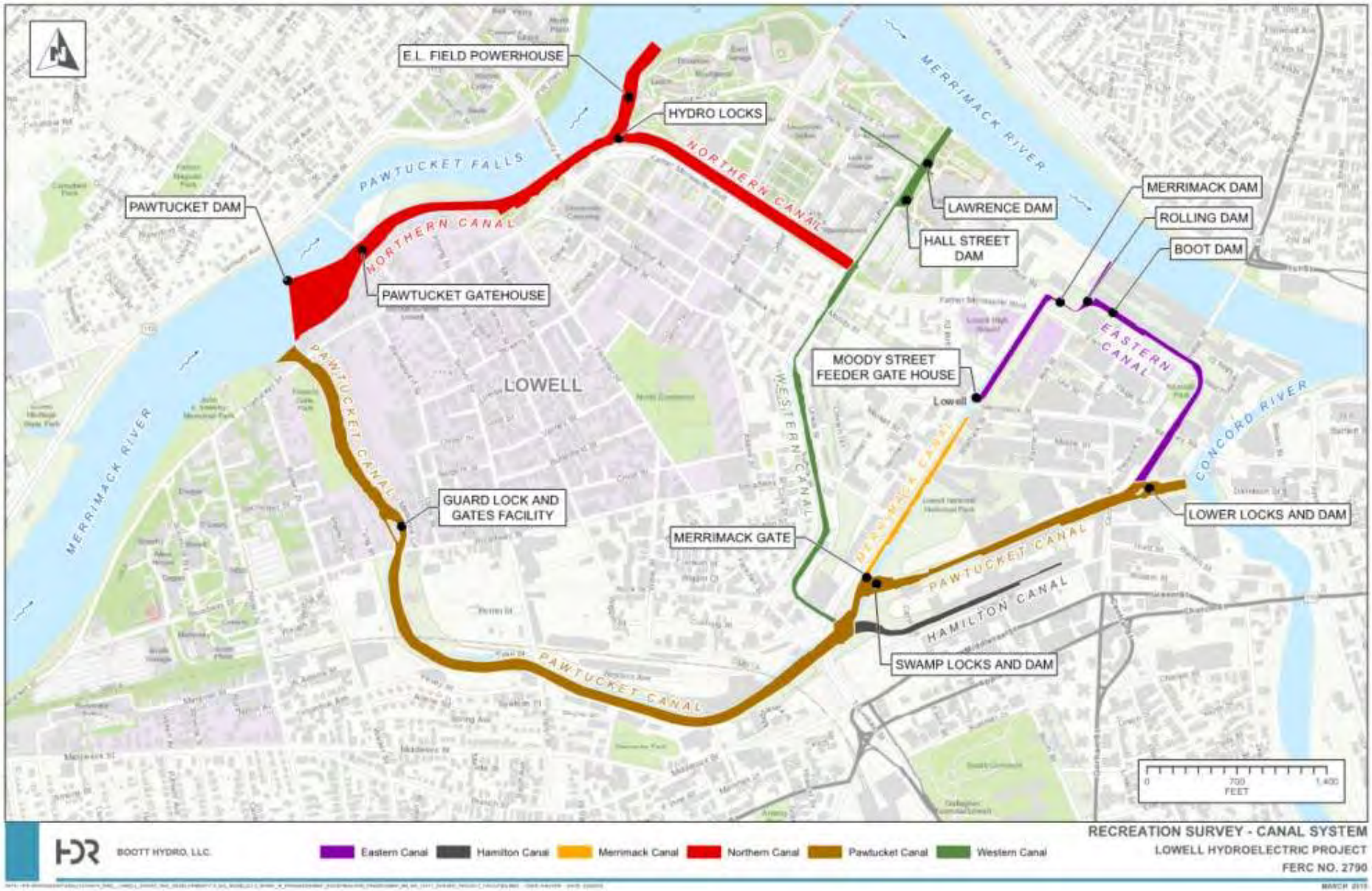
Q-13. Approximately how much money did you or do you intend to spend in preparation for or in association with your recreational trip to the Lowell Project (meals, gas, lodging, equipment, etc.)

A. $_____

Q-14. On previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in any of the canals shown in the figure below?

	Totally Unacceptable	**Unacceptable**	**Neutral**	**Acceptable**	**Totally Acceptable**
Eastern Canal	1	2	3	4	5
Hamilton Canal	1	2	3	4	5
Merrimack Canal	1	2	3	4	5
Northern Canal	1	2	3	4	5
Pawtucket Canal	1	2	3	4	5
Western Canal	1	2	3	4	5

Lowell Canal System



Q-15. On previous trips to the Project, please rate the following:

	Accessibility	Parking	Crowding	Condition of Recreation Facilities	Available Amenities	River/Canal Flow	Overall Experience
Lowell Heritage State Park							
Merrimack River Trail							
E.L. Field Powerhouse Visitor Center							
NPS Walkway Tours							
Riverwalk Ramble							
Waterpower Walk							
Heritage Hike							
Northern Canal Walkway							
Redevelopment Rove							
Boat access facilities							
Rourke Brothers Boat Ramp							
Pawtucket Falls Overlook							
Chelmsford Boat Access							
Merrill Park							
Greeley Boat Ramp							
Moore's Falls Conservation Area							
Informal Shoreline Parking/Access Areas							

Please use the following numerical scale to rate the formal recreation areas at the Lowell Project:
1) Totally Unacceptable; 2) Unacceptable; 3) Neutral; 4) Acceptable; 5) Totally Acceptable

Q-16. Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project.

1. Type of recreation enhancement:_____

   Location(s):_____
   _____

2. Type of recreation enhancement:_____

   Location(s):_____
   _____

3. Type of recreation enhancement:_____

   Location(s):_____
   _____

Q-17. Please share any other comments that you have regarding recreation at the Lowell Project:_____
_____
_____
_____
_____
_____
_____
_____
_____

Thank you for completing the Recreation Survey!

Online Recreation Survey Form

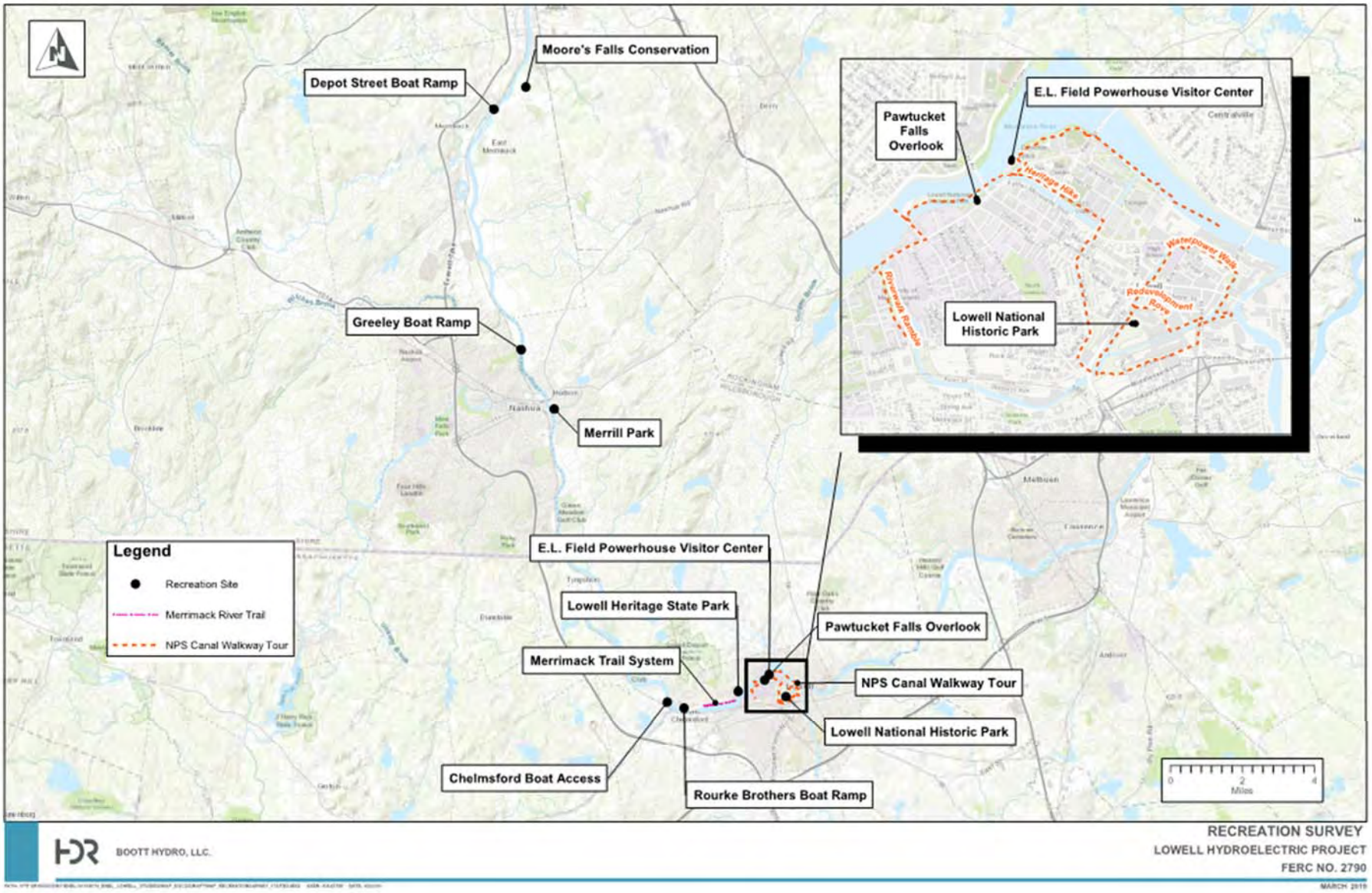
Boott Hydropower, LLC (Boott), a subsidiary of Enel Green Power North America, Inc., owns and operates the Lowell Project, which is licensed by the Federal Energy Regulatory Commission (FERC). The current operating license for the Lowell Project was issued on May 1, 1973 and expires on April 30, 2023. Boott will file its application with FERC for a new license for continued project operation no later than April 30, 2021. As part of this relicensing process, Boott is conducting a series of resource studies to enable FERC to prepare its environmental review document and develop a new operating license.

The purpose of this survey is to gather information regarding participation in outdoor recreation activities at the Lowell Project.

The E.L. Field Powerhouse Visitor Center is the Lowell Project's only formal recreation area. Other, non-Project recreation facilities are also located near the Lowell Project, including the Lowell National Historical Park, Merrimack River Trail, Pawtucket Falls Overlook, boat access facilities on the Lowell Project impoundment, and the Rourke Brothers Boat Ramp. These and other non-Project facilities are not owned or operated by Boott, but are popular Merrimack River recreational areas. In addition, there are numerous informal access areas on Lowell Project lands that are used by the public to access the Merrimack River.

The Lowell Project area relevant to this survey is defined on the map. The information provided in this survey will inform the development of appropriate management measures for recreational resources at the Lowell Project.

Lowell Project Area Recreation Map



Q-1. What is the zip code of your primary residence? _____

Q-2. What is your age? _____

Q-3. Are you: Male ☐ Female ☐ Prefer not to answer ☐

Q-4. Regarding the Lowell Project area, do you consider yourself:

5. A regular visitor to this area (*3 or more times per year*)
6. An occasional visitor (*1-2 times per year*)
7. An infrequent visitor (*Less than 1 time per year*)

Q-5. During the last 12 months, which month(s) did you visit the Lowell Project area? *(select all that apply)*?

Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐

I have not visited in the last 12 months ☐

Q-6. Which of the following recreation areas at or near the Lowell Project did you utilize for recreation during the past 12 months? **(Please select all that apply)**

21. Lowell Heritage State Park
22. Merrimack River Trail
23. E.L. Field Powerhouse Visitor Center
24. NPS Walkway Tours
25. Riverwalk Ramble
26. Waterpower Walk
27. Heritage Hike
28. Northern Canal Walkway
29. Redevelopment Rove
30. Boat access facilities on the Lowell Project impoundment
31. Lowell Heritage State Park – Rourke Brothers Boat Ramp
32. Pawtucket Falls Overlook (Lowell, MA)
33. Chelmsford Boat Access (Chelmsford, MA)
34. Merrill Park (Hudson, NH)
35. Greeley Boat Ramp (Nashua, NH)
36. Depot St. Boat Ramp (Merrimack, NH)
37. Moore's Falls Conservation Area (Litchfield, NH)
38. Informal Shoreline Parking/Access Areas
39. None of the above
40. Other (Please list)

_____
_____
_____

Q-7. On your last trip, about how many miles did you travel to get to the Lowell Project?

A. _____miles

Q-8. During the past 12 months, when did you visit the Lowell Project? **(Please select one)**

1. Only on weekdays (Monday – Friday)
2. Only on weekends (Saturday or Sunday) and/or holidays
3. Both weekdays AND weekends and/or holidays

Q-9. On previous visits to the Lowell Project have you stayed overnight (not including your own home)?

2. Yes 2. No

Q-10. At what type of accommodations do you usually stay? (**Please select one)**

6. RV/Auto/Tent Campground
7. Motel/hotel
8. Bed and Breakfast
9. Vacation or Rental Home
10. Other (Please specify: _____)

Q-11. What was the approximate size of your group during your last trip to the Lowell Project area?

A. _____people

Q-12. Which of the following best describes your group during previous trips to the Lowell Project Area?

6. Individual
7. Adult group (over 21)
8. Youth group (under 21)
9. Family (with children)
10. Mixed group (groups with children, adults, and/or teens)

Q-13. On previous trips to the Lowell Project area, in which of the following activities have you or do you expect to participate? (**Please select all that apply**)

1. Bank fishing	12. Canoeing	24. RV camping
2. Boat fishing	13. Kayaking	25. Tent camping
3. Guided fishing experience	14. Commercial whitewater boating	26. Photography
4. Walking tour	15. Museum-going	27. Sightseeing
5. Hiking	16. Shopping and/or dining	28. Relaxing
6. Backpacking	17. Swimming	29. Sunbathing
7. Guided canal tours	18. Off-highway vehicle (dirt bike/ATV)	30. Dog walking
8. Historical/heritage site visits	19. Horseback riding	31. Painting/drawing
9. Running, jogging, and fitness	20. Off-road mountain biking	32. Other (please describe):

10. Rock climbing/bouldering	21. Road cycling
11. Picnicking	22. Adventure sports
	23. Geo-caching

Q-14. Of the activities you circled in **Q-13** above, what is the primary activity that you participated in during previous visits? (**Please write in the corresponding number from above**)

A. Primary activity # _____

Q-15. You selected (Primary Activity Number) as the Primary activity in Question 14. Please rate the following:

	Totally Unacceptable	Unacceptable	Neutral	Acceptable	Totally Acceptable
Challenge	1	2	3	4	5
Safety	1	2	3	4	5
Enjoyment	1	2	3	4	5
River/Canal Flow	1	2	3	4	5
Crowding	1	2	3	4	5
Overall Experience	1	2	3	4	5

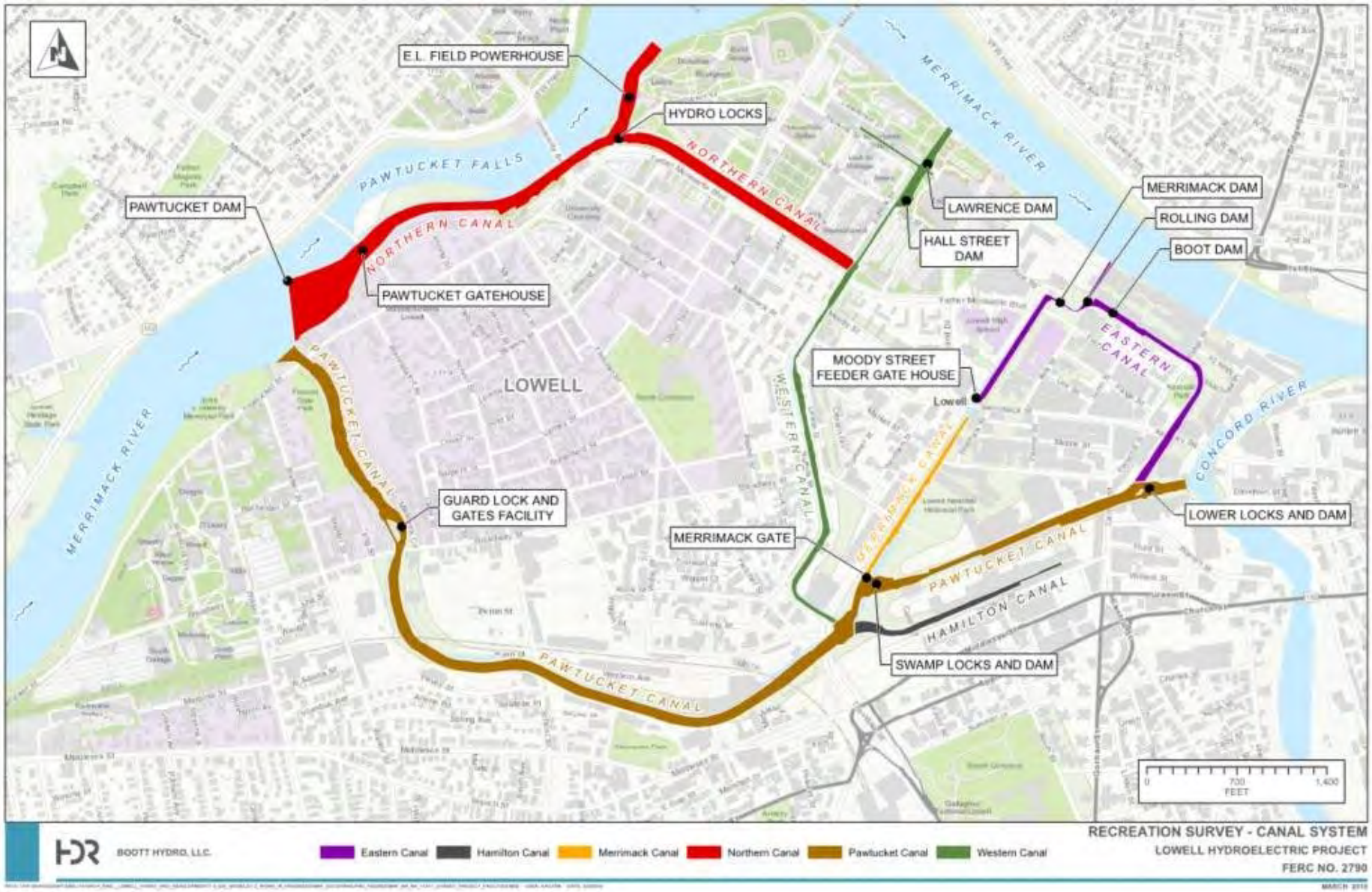
Q-16. Approximately how much money did you spend in preparation for or in association with your last recreational trip to the Lowell Project (meals, gas, lodging, equipment, etc.)?

A. $_____

Q-17. On previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in any of the canals shown in the below figure?

	Totally Unacceptable	Unacceptable	Neutral	Acceptable	Totally Acceptable
Eastern Canal	1	2	3	4	5
Hamilton Canal	1	2	3	4	5
Merrimack Canal	1	2	3	4	5
Northern Canal	1	2	3	4	5
Pawtucket Canal	1	2	3	4	5
Western Canal	1	2	3	4	5

Lowell Canal System



Q-19. Thinking about your visit to the Lowell Heritage State Park…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-20. Thinking about your visit to the Merrimack River Trail….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-21. Thinking about your visit to the E.L. Field Powerhouse Visitor Center…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-22. Thinking about your visit on the NPS Walkway Tours….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-23. Thinking about your visit to the Riverwalk Ramble….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-24. Thinking about your visit to the Waterpower Walk….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-25. Thinking about your visit to the Heritage Hike….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-26. Thinking about your visit to the Northern Canal Walkway….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-27. Thinking about your visit to the Redevelopment Rove….

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-28. Thinking about your visit to boat access facilities on the Lowell Project impoundment…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-29. Thinking about your visit to the Rourke Brothers Boat Ramp…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-30. Thinking about your visit to the Pawtucket Falls Overlook…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-31. Thinking about your visit to the Chelmsford Boat Access…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	

Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-32. Thinking about your visit to the Merrill Park…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-33. Thinking about your visit to the Greeley Boat Ramp…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-34. Thinking about your visit to the Depot St. Boat Ramp…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-35. Thinking about your visit to the Moore's Falls Conservation Area…

(please use the following numerical scale to rate the recreation area)

1.) Totally Unacceptable
2.) Unacceptable
3.) Neutral
4.) Acceptable
5.) Totally Acceptable

Accessibility	
Parking	
Crowding	
Safety	
Condition of Recreation Facilities	
Available Amenities	
River/Canal Flow	
Overall Experience	

Q-36. Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project.

4. Type of recreation enhancement:_____

   Location(s):_____
   _____

5. Type of recreation enhancement:_____

   Location(s):_____
   _____

6. Type of recreation enhancement:_____

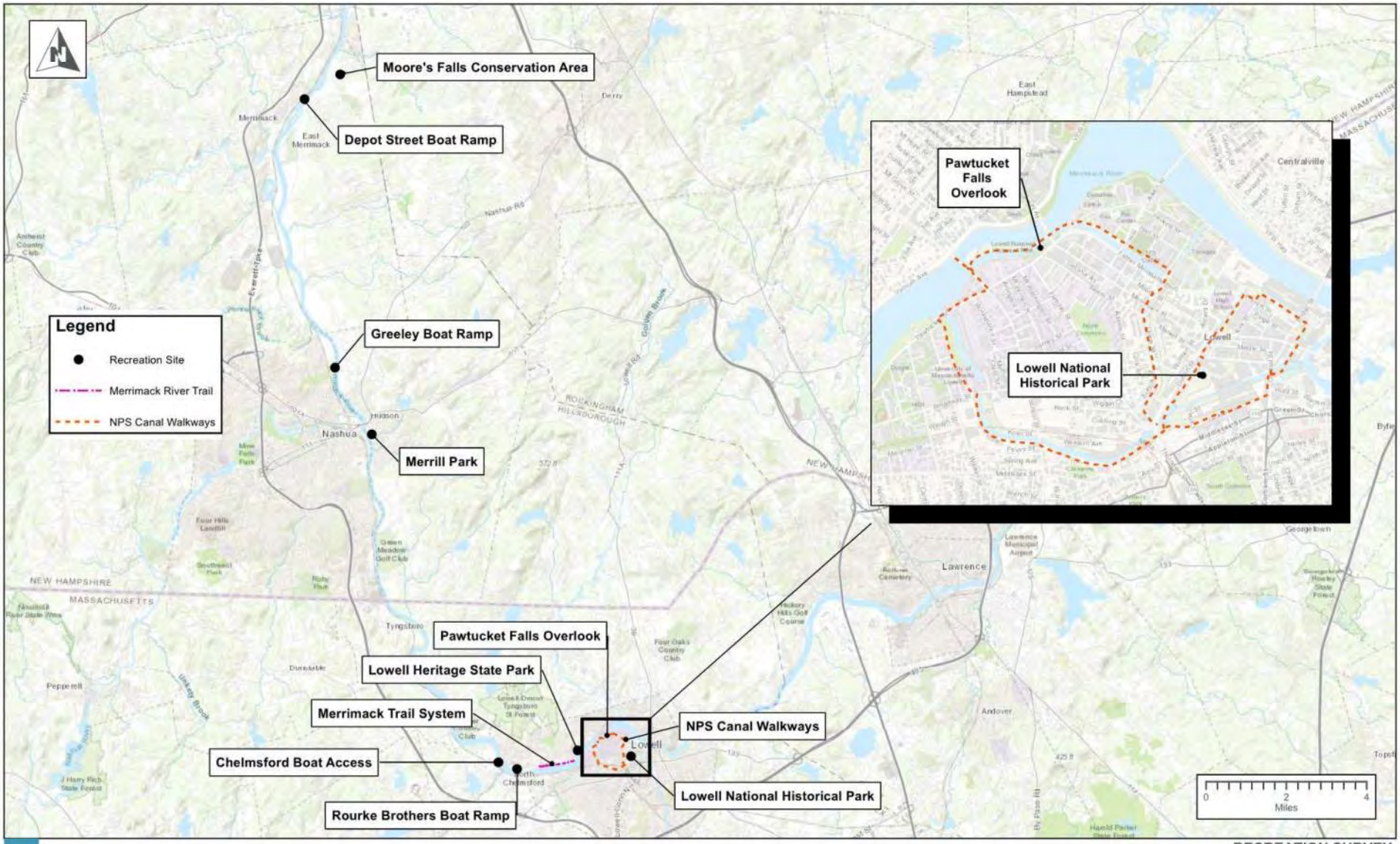
   Location(s):_____

Q-37. Please share any other comments that you have regarding recreation at the Lowell Project: _____
_____
_____

Thank you for completing the Online Recreation Survey!

Appendix B - Recreation Inventory Map and Notes

Map of Recreation Inventory Areas



BOOTT HYDRO, LLC.

RECREATION SURVEY

LOWELL HYDROELECTRIC PROJECT

FERC NO. 2790

APRIL 2020

Recreation Inventory Notes

Chelmsford Boat Access
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking lot for approximately 50 cars - Parking circle - Boat trailer only parking	- Signage with public launch information - Kiosk with boat access rules and regulations - Blank kiosk	- Boat ramp - River trail - Picnicking tables - Waste receptacles	- Structural damage to boat ramp - Picnic tables noted to need ongoing maintenance - Trash receptables in good condition	- Baseball/softball fields

Photo 1 – Chelmsford Boat Access Kiosk

Photo 2 – Chelmsford Boat Access Ramp

Depot Street Boat Ramp
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- 6-8 car capacity parking lot - Emergency parking - Offstreet overflow parking	- Signage with public boat ramp information - Kiosk with boat access rules and regulations - Kiosk with information on the Landing Site of Reeds Ferry	- Boat ramp - Short trail to boat ramp with tunnel - Trash receptacles	- Boat ramp in good condition - Trail in good condition - Trash receptacles noted in good condition	- Grassy area for picnicking -

Photo 3 – Depot Street Boat Ramp Sign

Photo 4 – Depot Street Boat Ramp

Greeley Boat Ramp
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking for 2 near boat ramp - Parking for 4 just above boat ramp	- Entry signage with park hours and rules - Poor, unreadable signage near boat ramp	- Boat ramp - Off-road trail	- Boat ramp reported in good condition - Trail noted in good condition	- Access road

Photo 5 – Access road to Greeley Boat Ramp

Photo 6 – Greeley Boat Ramp

Lowell Heritage State Park
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- 20-30 car parking lot - Street parking	- Signage with rules, directions, and park hours	- Outdoor stage with grassy lawn - Sand beach - Benches - Pavilion - Emergency boat ramp	- All recreation amenities reported in good condition	- Restrooms inside building - Waste receptacles

Photo 7 – Parking lot at Lowell Heritage State Park

Photo 8 – Outdoor stage at Lowell Heritage State Park

Photo 9 – Beach at Lowell Heritage State Park

Lowell National Historical Park (Visitor Center)
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Ample free car parking lot (~100 spots) -	- "Bus, RV and Trailer Parking Only" - Lowell National Historical Park Visitor Center Sign - Visitor Center Sign with hours - Map of Lowell National Historical Park Features	- Standing exhibits with historical and hydropower information - Interactive equipment for education - Restrooms and water-fountain	- All recreation amenities reported in good condition	- Information front desk - Wheel chair ramp - Gift shop - Restrooms

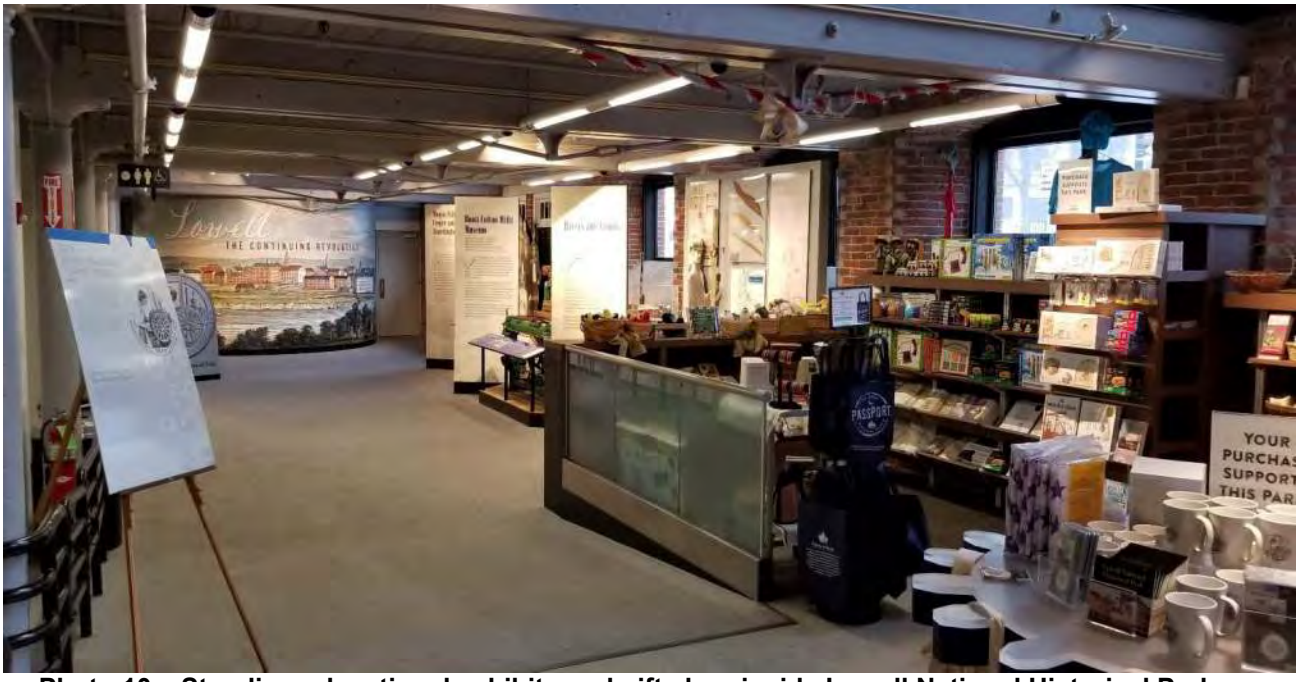


Photo 10 – Standing educational exhibits and gift shop inside Lowell National Historical Park Visitor Center

Photo 11 – Map of canal layout and Lowell National Historical Park Features (located inside Visitor Center)

Merrill Park
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- No formal park lot Dirt parking area for approximately 5 cars	- Entry sign to park	- Walking trail - Hand-carry launch area	- Parking area is minimal, could be graded, many deep ruts - Hand-carry launch and walking trail acceptable	- Bicycle motocross jump - Adjacent to graveyard (common area for dog walking)

Photo 12 – Entry sign to Merrill Park

Photo 13 –Access road to Merrill Park

Merrimack Trail System
Recreation Inventory
December 17, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking for approximately 20 cars - Street parking	- Welcome sign with rules and hours	- Trail to water - Walking trails - Benches - Trash receptacles - Bathrooms	- All recreation amenities reported in good condition	- Not applicable

Photo 14 – Walking Path

Moore's Falls Conservation Area
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking lot for 7-11 cars	- Welcome kiosk with rules and information on young forest and shrubland - Welcome sign with rules - Caution signs regarding hunting and other uses of the area - Educational exhibits with environmental information	- Trails - Educational exhibits	- All recreation amenities reported in good condition	- Birdhouses

Photo 15 – Welcome Kiosk to Moore's Falls Conservation Area

Photo 16 – Birdhouses at Moore's Falls Conservation Area

National Park Service Canal Walkways
Recreation Inventory
December 17, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking available at NPS Visitor Center	- Information and direction signs - Educational exhibits and signs	- Canalways - Benches - Education signs - Lighting	- All recreation amenities reported in good condition	- Not applicable

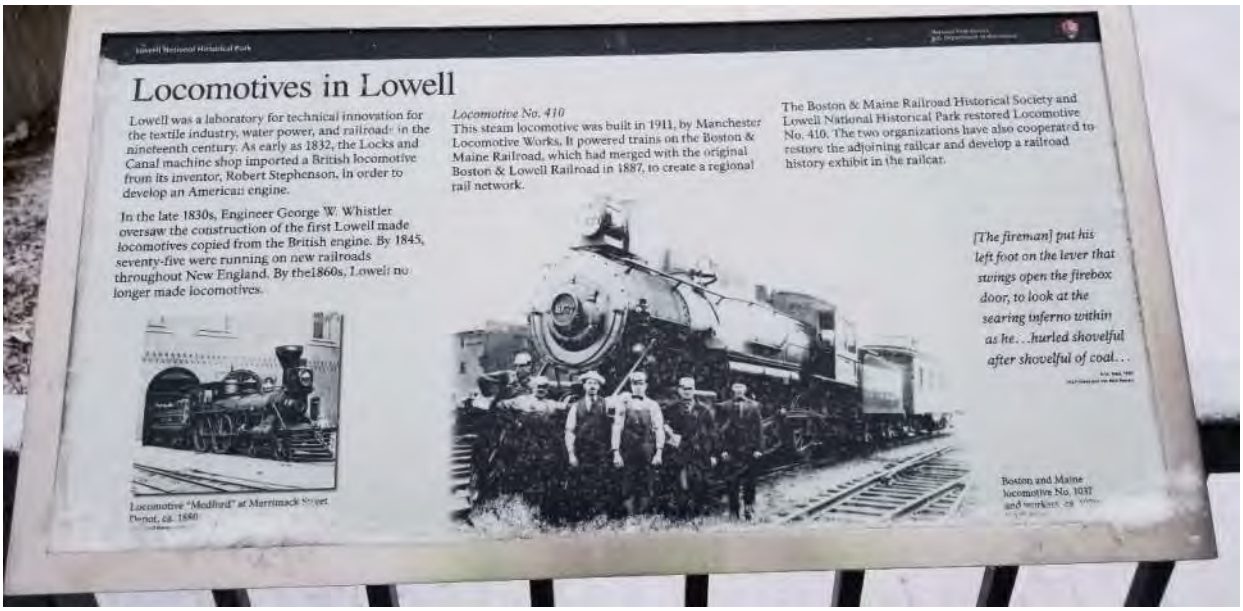


Photo 17 – Example photograph of educational signs


Photo 18 – Canalways and benches along Merrimack Canal Walk

Pawtucket Falls Overlook
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Not applicable	- Educational signage	- Overlook area	- Good condition	- Not applicable

Photo 19 – Educational sign at the Pawtucket Falls Overlook


Photo 20 – View of dam and Pawtucket Falls from Pawtucket Falls Overlook

Rourke Brothers Boat Ramp
Recreation Inventory
December 16, 2019

Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- Parking for approximately 60 cars - Handicap parking/ADA-compliant	- Welcome sign - Kiosk with rules and regulations - Rourke Brothers Memorial Sign	- Boat ramp - Dock - Tables	- All recreation amenities reported in good condition	- Grassy picnic areas

Photo 21 – Kiosk with rules and regulations

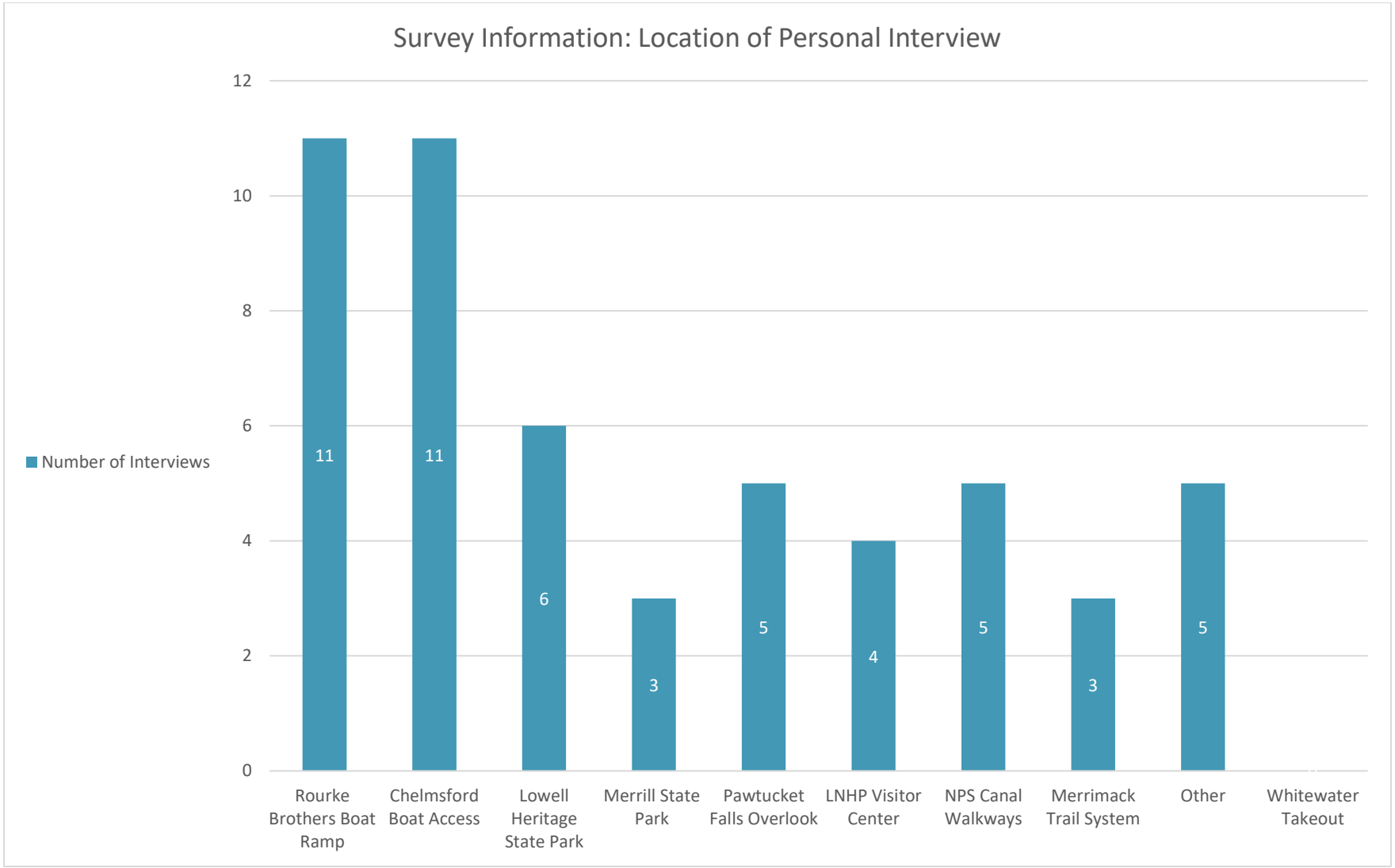

Photo 22 – Paved Rourke Brothers Boat Ramp

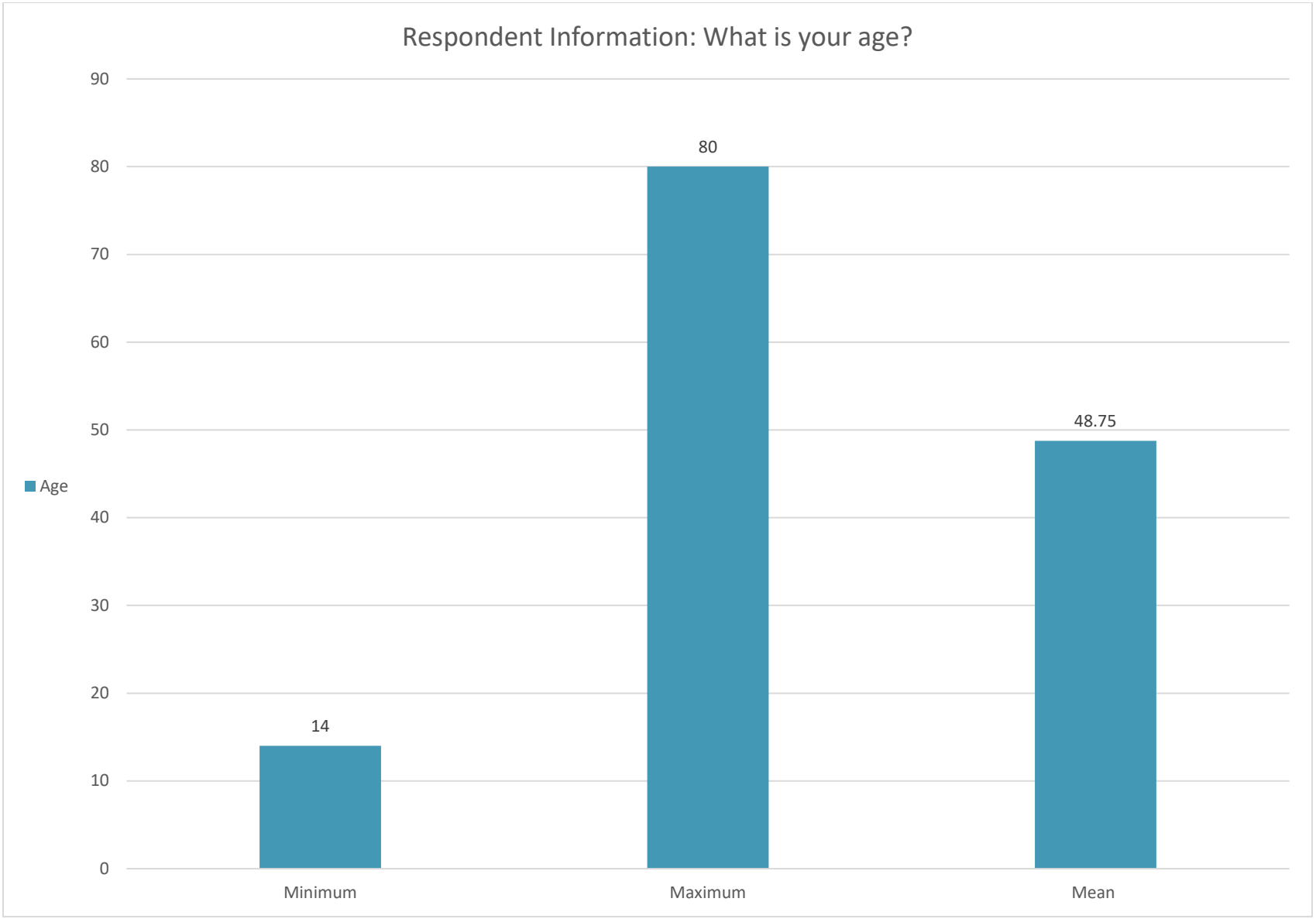
E.L. Field Powerhouse Visitor Center
Recreation Inventory
December 16, 2019

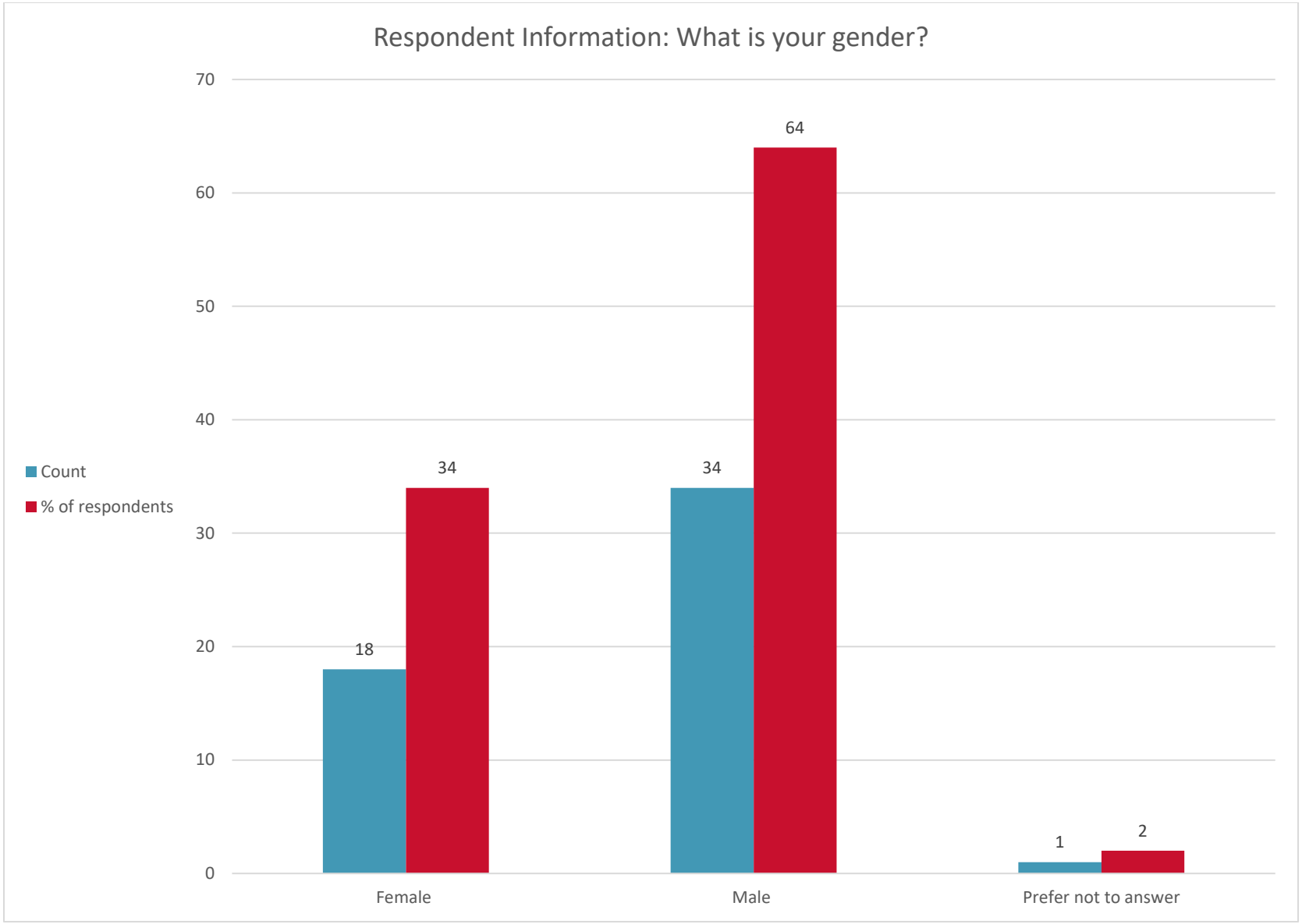
Parking	Signage	Recreation Amenities	Condition of Recreation Amenities	Additional Features
- **Large locked gated area available for parking** - **Asphalt/gravel parking area**	- Welcome sign	- Standing exhibits with historical and hydropower information - Interactive and interpretive equipment for education	- Reported in good condition	- ADA-compliant elevator

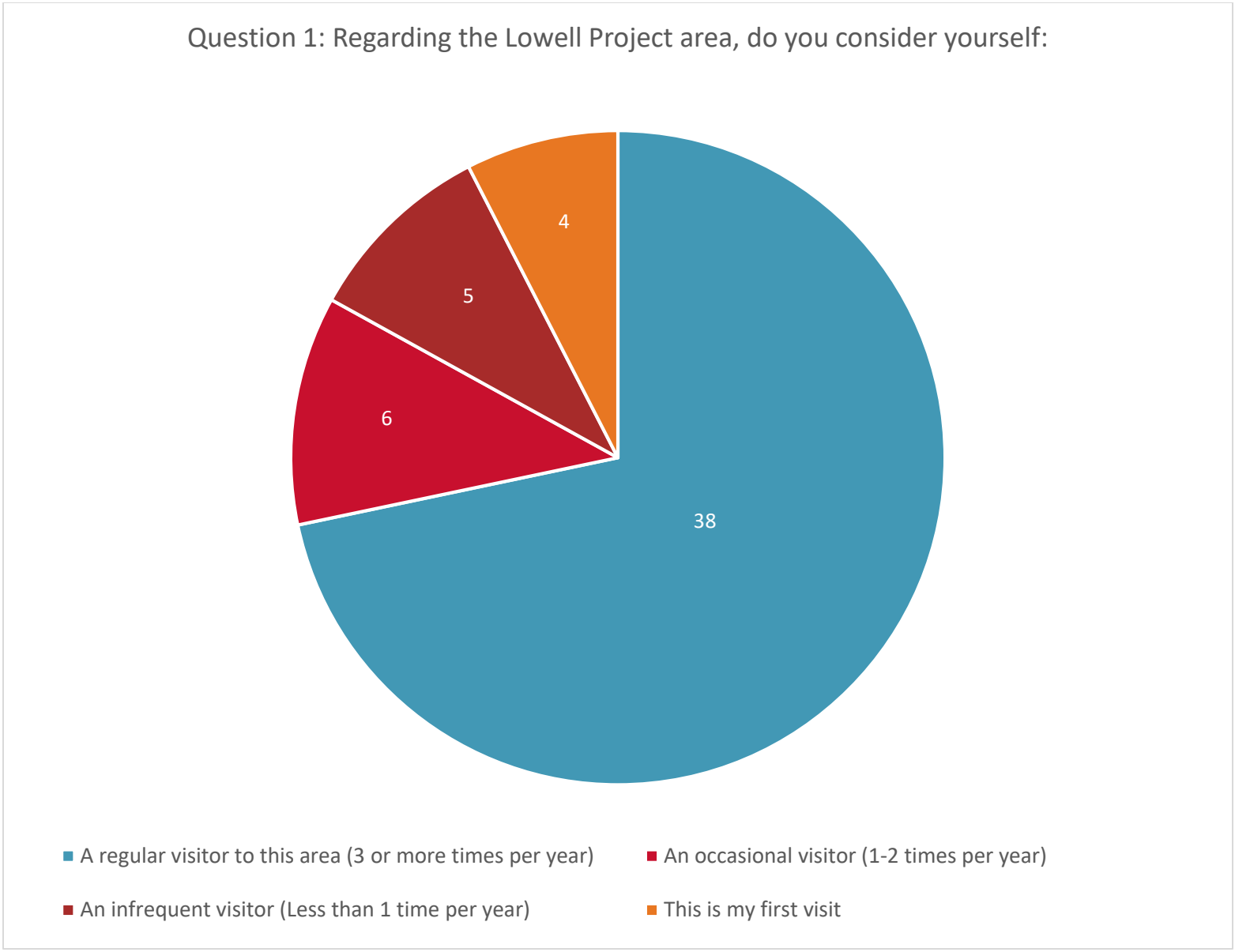
*****The E.L. Field Powerhouse Visitor Center was closed the days of inventory. Only the outside portions were included in this inventory.

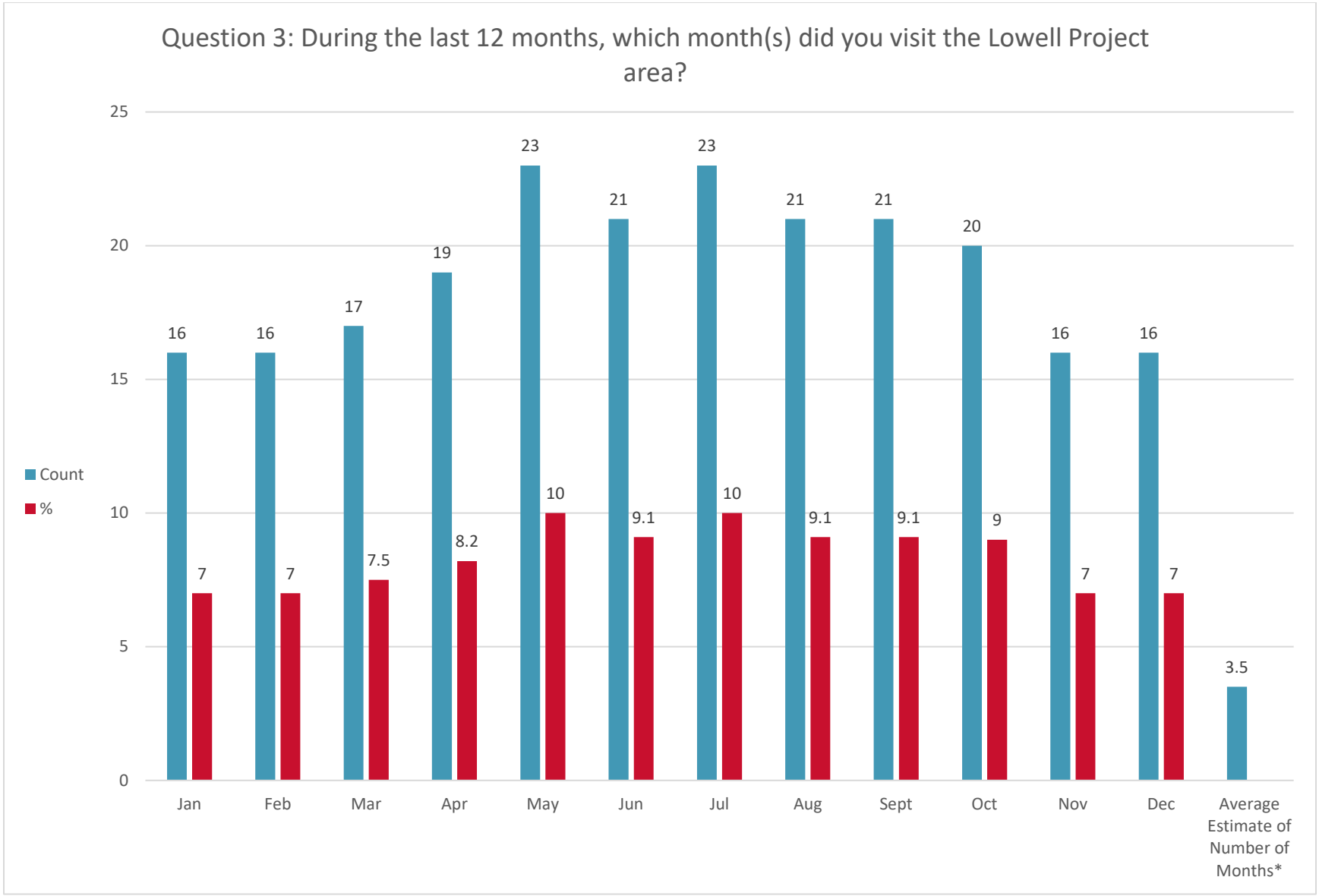
Appendix C - Personal Interview/Visitor-Intercept Survey Data


Survey Information: Location of Personal Interview
Number of Interviews
12
10
8
6
4
2
0
11
11
6
3
5
4
5
3
5
Rourke Brothers Boat Ramp
Chelmsford Boat Access
Lowell Heritage State Park
Merrill State Park
Pawtucket Falls Overlook
LNHP Visitor Center
NPS Canal Walkways
Merrimack Trail System
Other
Whitewater Takeout

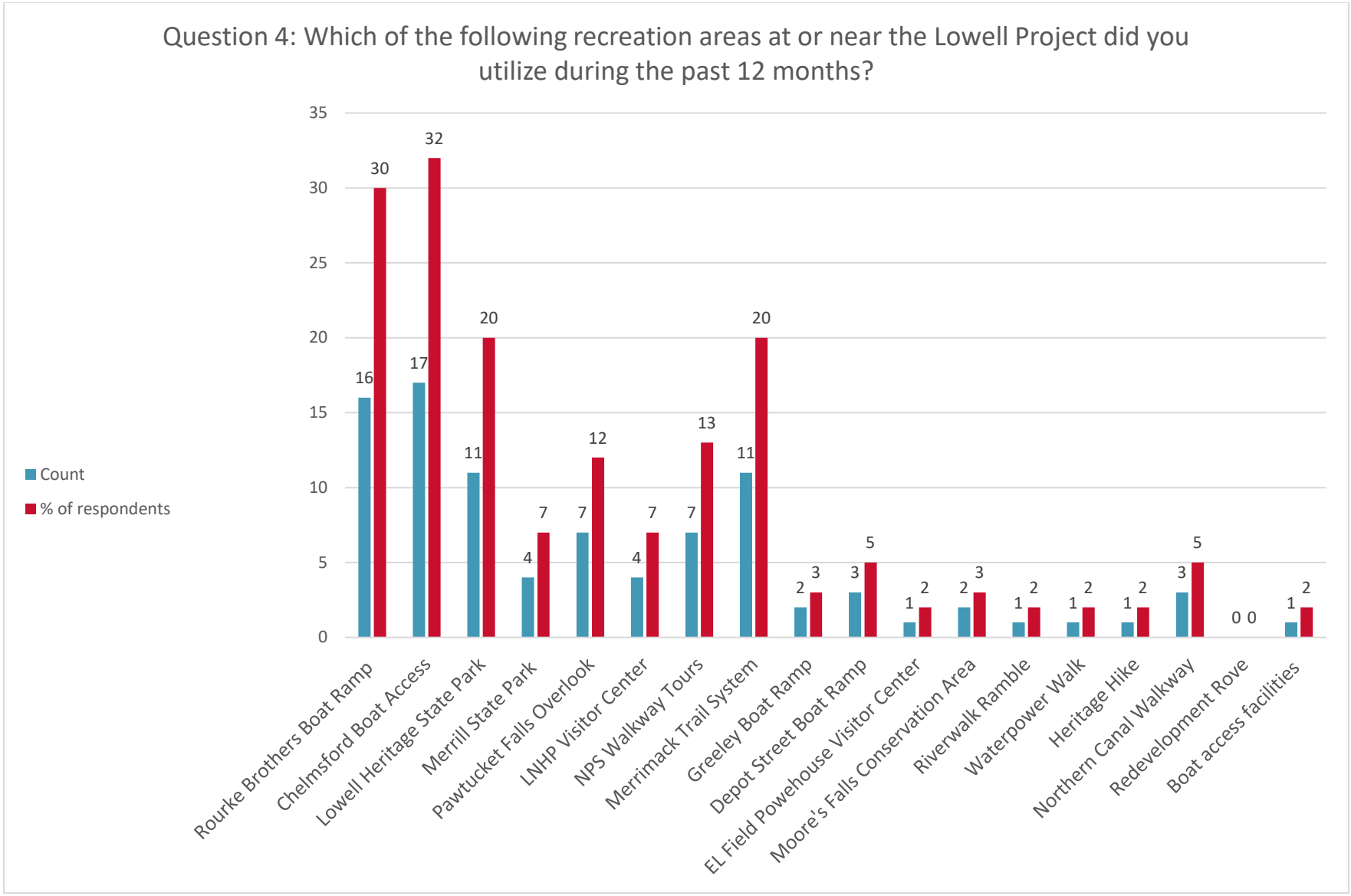

Respondent Information: What is your age?
90
80
70
60
50
40
30
20
10
0
Age
80
48.75
14
Minimum
Maximum
Mean

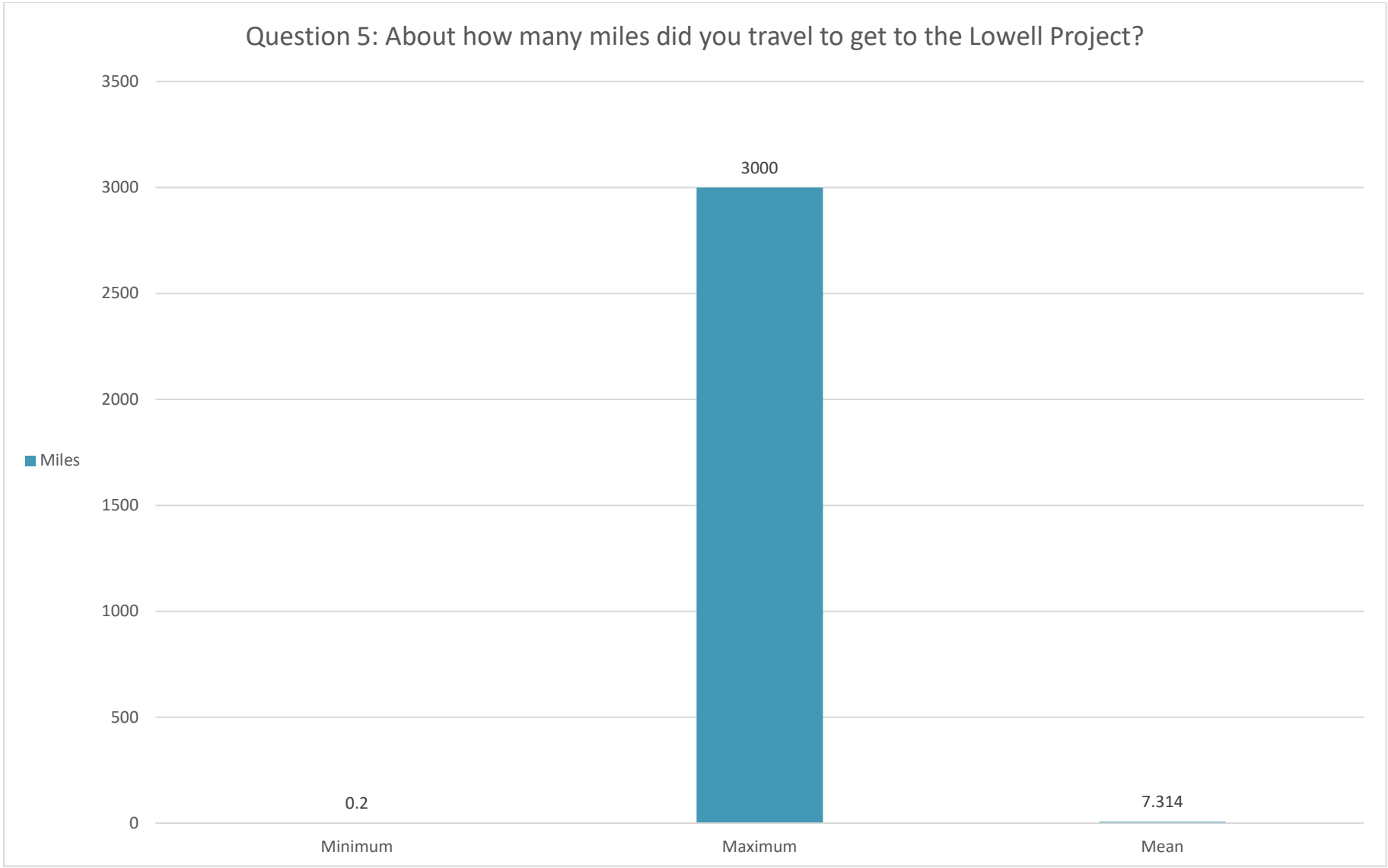

Respondent Information: What is your gender?
70
60
50
40
30
20
10
0
Count
% of respondents
18
34
34
64
1
2
Female
Male
Prefer not to answer


Question 1: Regarding the Lowell Project area, do you consider yourself:
38
6
5
4
A regular visitor to this area (3 or more times per year)
An occasional visitor (1-2 times per year)
An infrequent visitor (Less than 1 time per year)
This is my first visit

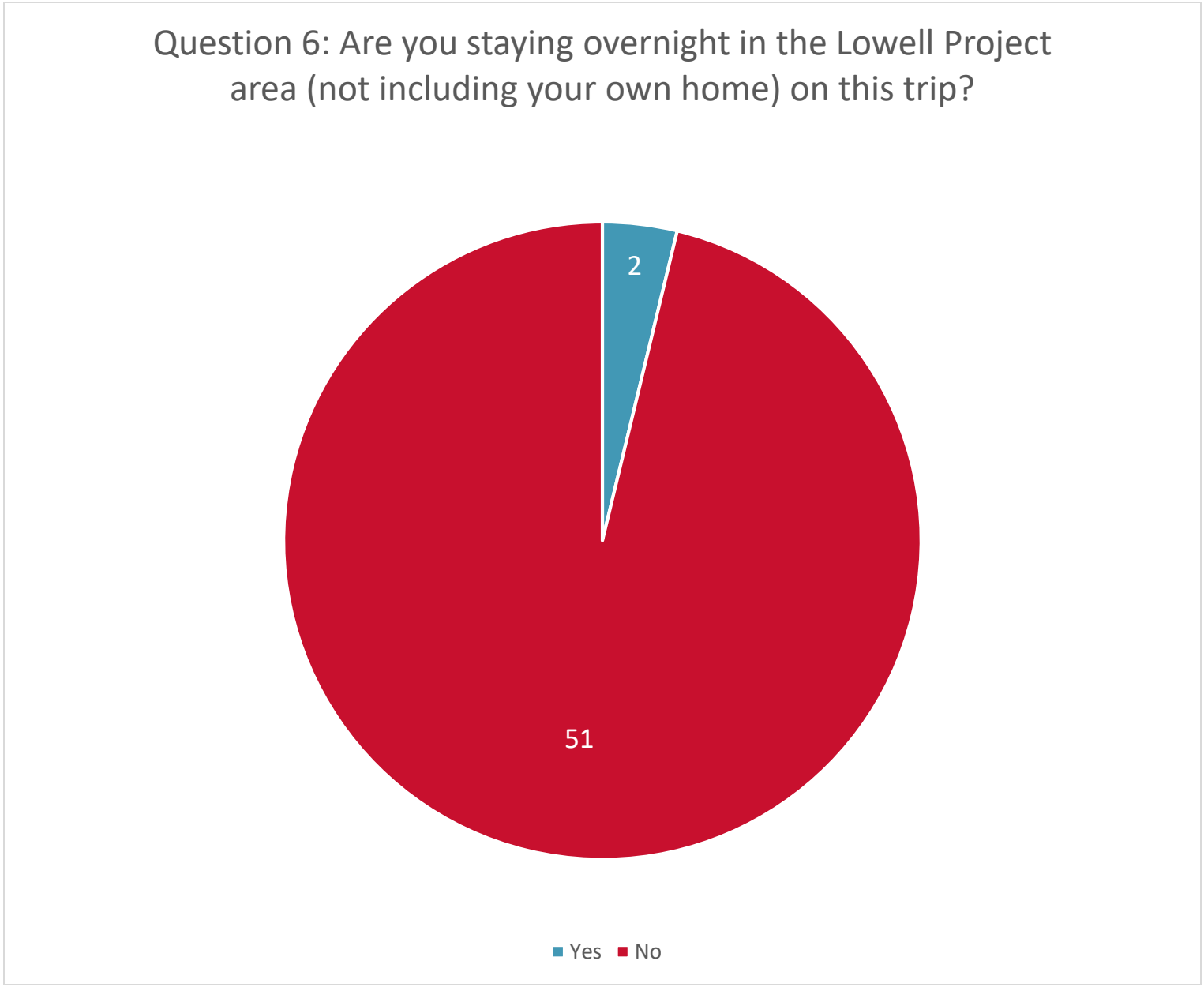


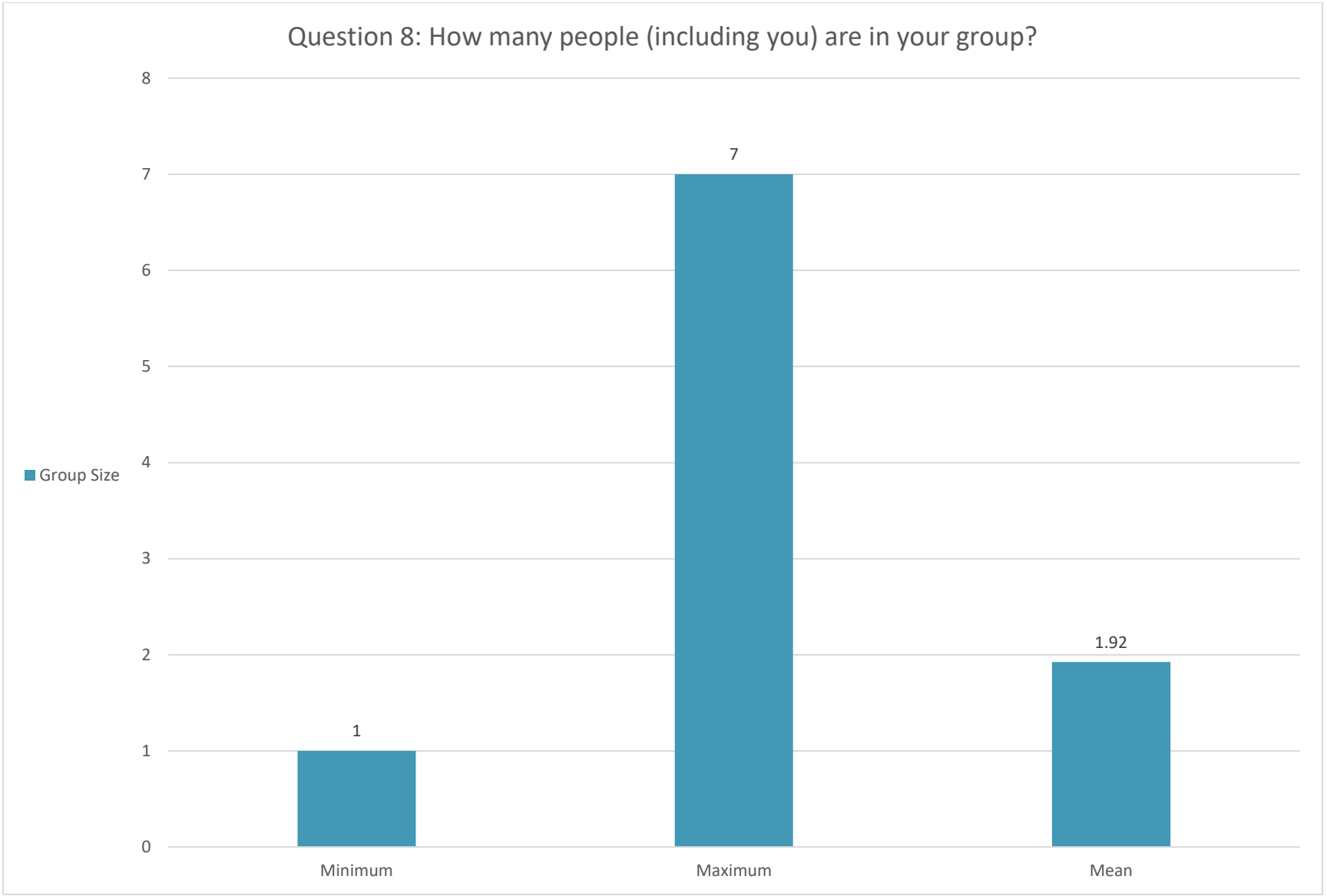
*A small number of respondents interpreted Question 3 as asking how many months during the last 12 months they visited the Project. This is the average of those responses.


Question 4: Which of the following recreation areas at or near the Lowell Project did you utilize during the past 12 months?
Count
% of respondents
35
30
25
20
15
10
5
0
16
30
17
32
11
20
4
7
7
12
4
7
7
13
11
20
2
3
3
5
1
2
2
3
1
2
1
2
1
2
3
5
0 0
1
2
Rourke Brothers Boat Ramp
Chelmsford Boat Access
Lowell Heritage State Park
Merrill State Park
Pawtucket Falls Overlook
LNHP Visitor Center
NPS Walkway Tours
Merrimack Trail System
Greeley Boat Ramp
Depot Street Boat Ramp
EL Field Powehouse Visitor Center
Moore's Falls Conservation Area
Riverwalk Ramble
Waterpower Walk
Heritage Hike
Northern Canal Walkway
Redevelopment Rove
Boat access facilities

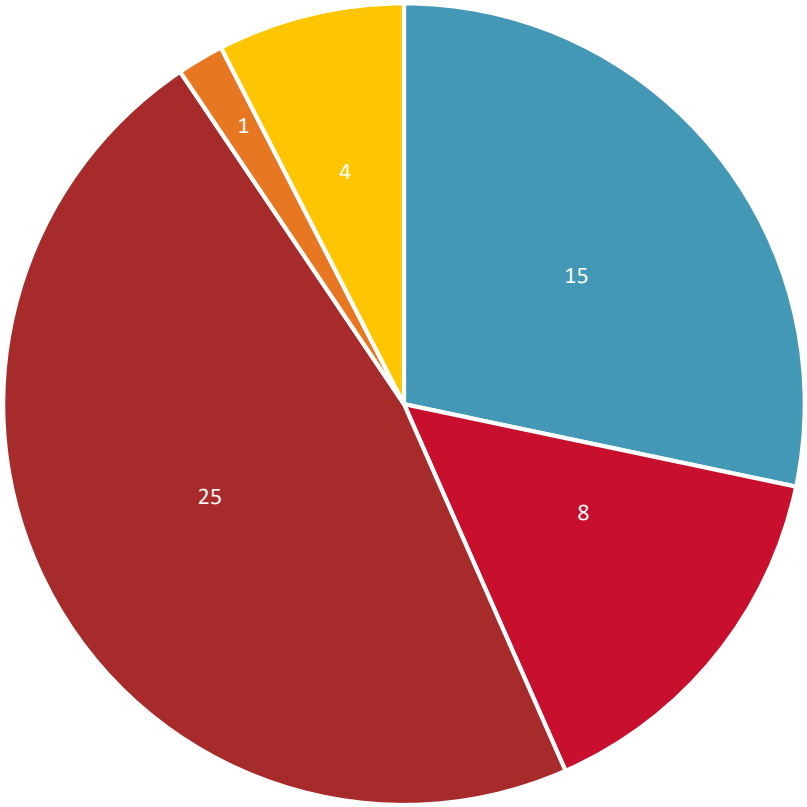


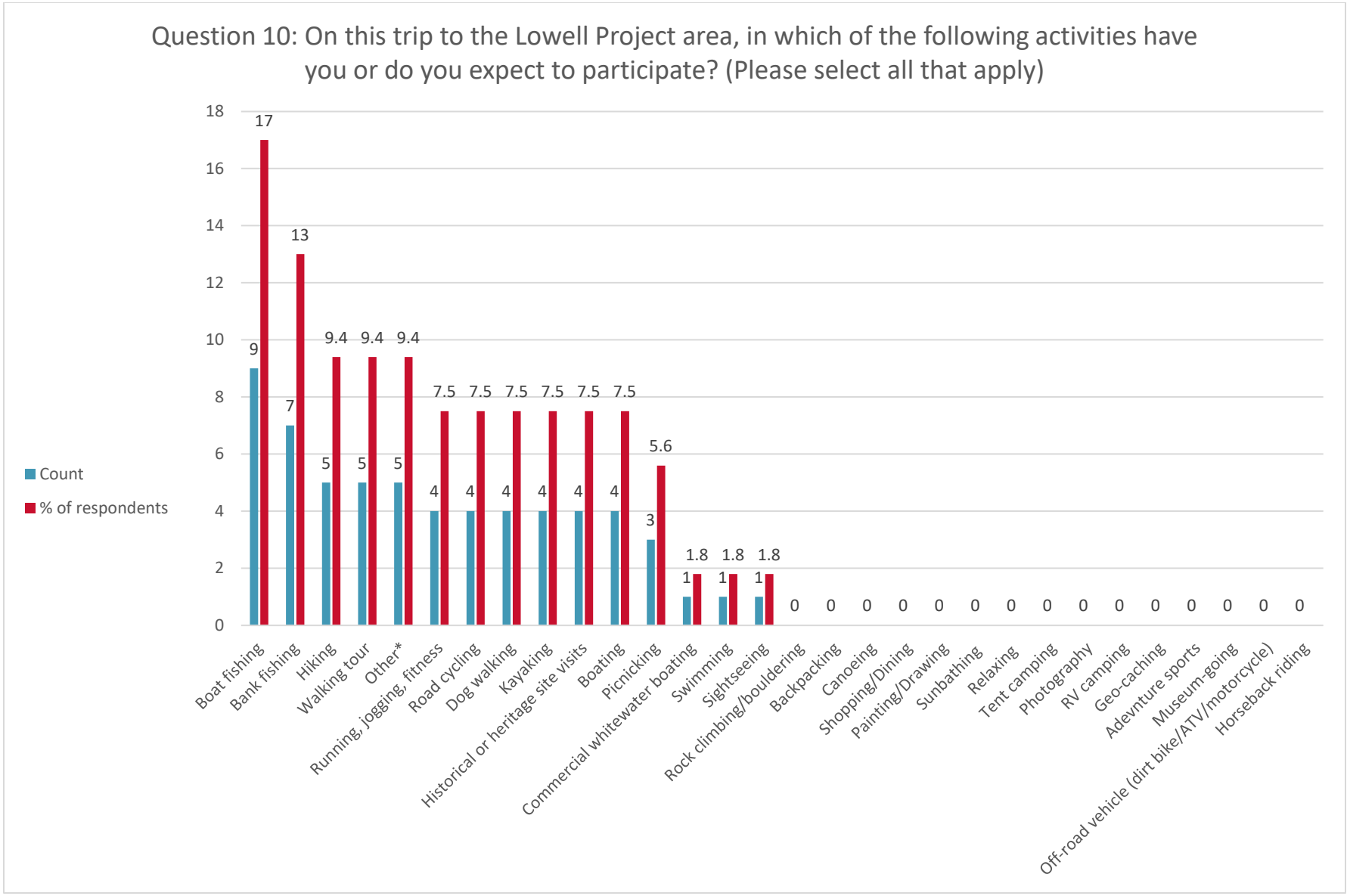
*The mean does not include the 3,000 miles as it would significantly skew the results. To see the full list of respondent residential zip codes and a representative map, see Appendix F.


Question 6: Are you staying overnight in the Lowell Project area (not including your own home) on this trip?
2
51
Yes
No

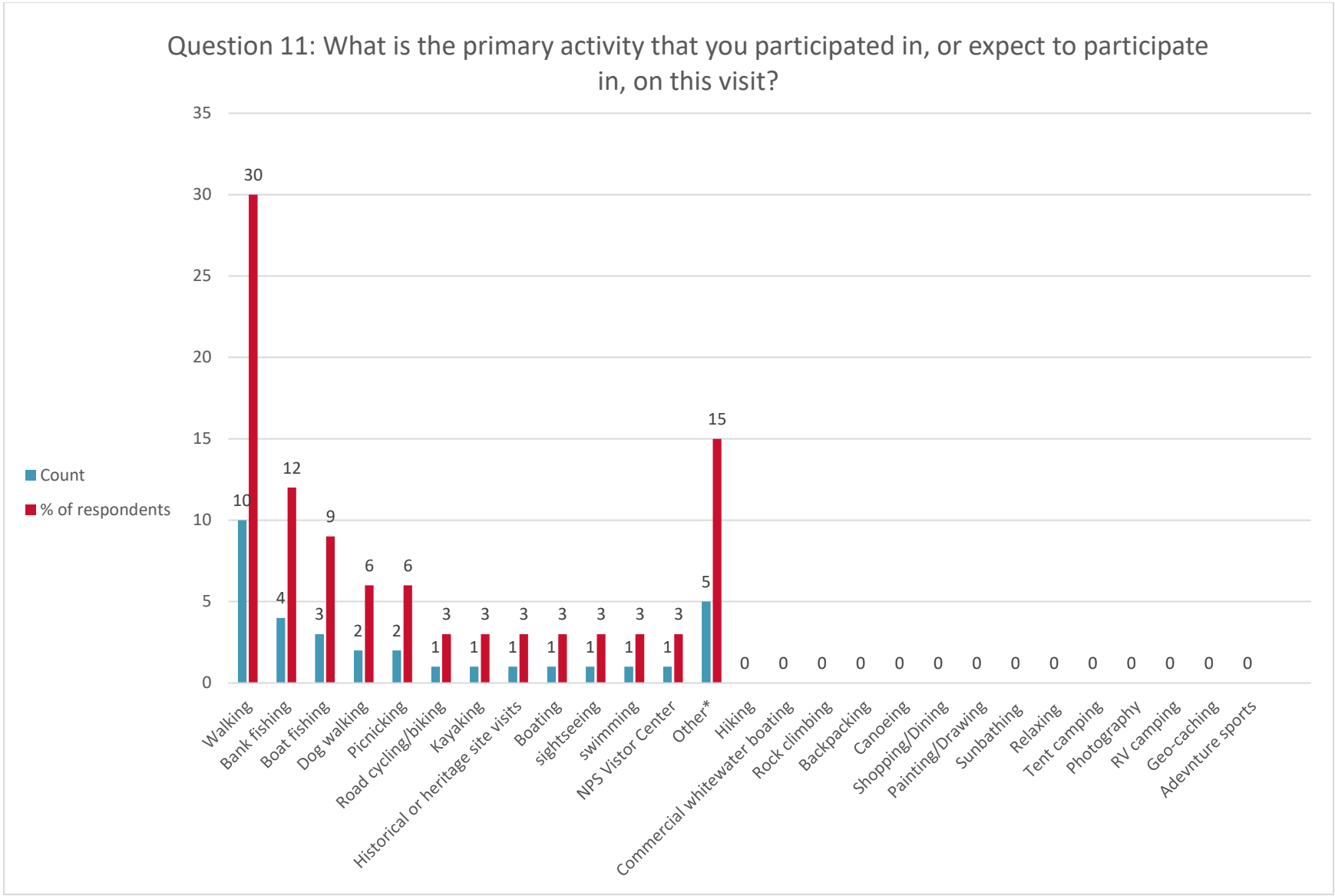

Question 8: How many people (including you) are in your group?
8
7
6
5
4
3
2
1
0
Group Size
1
7
1.92
Minimum
Maximum
Mean

Question 9: Which of the following best describes your group during this trip?

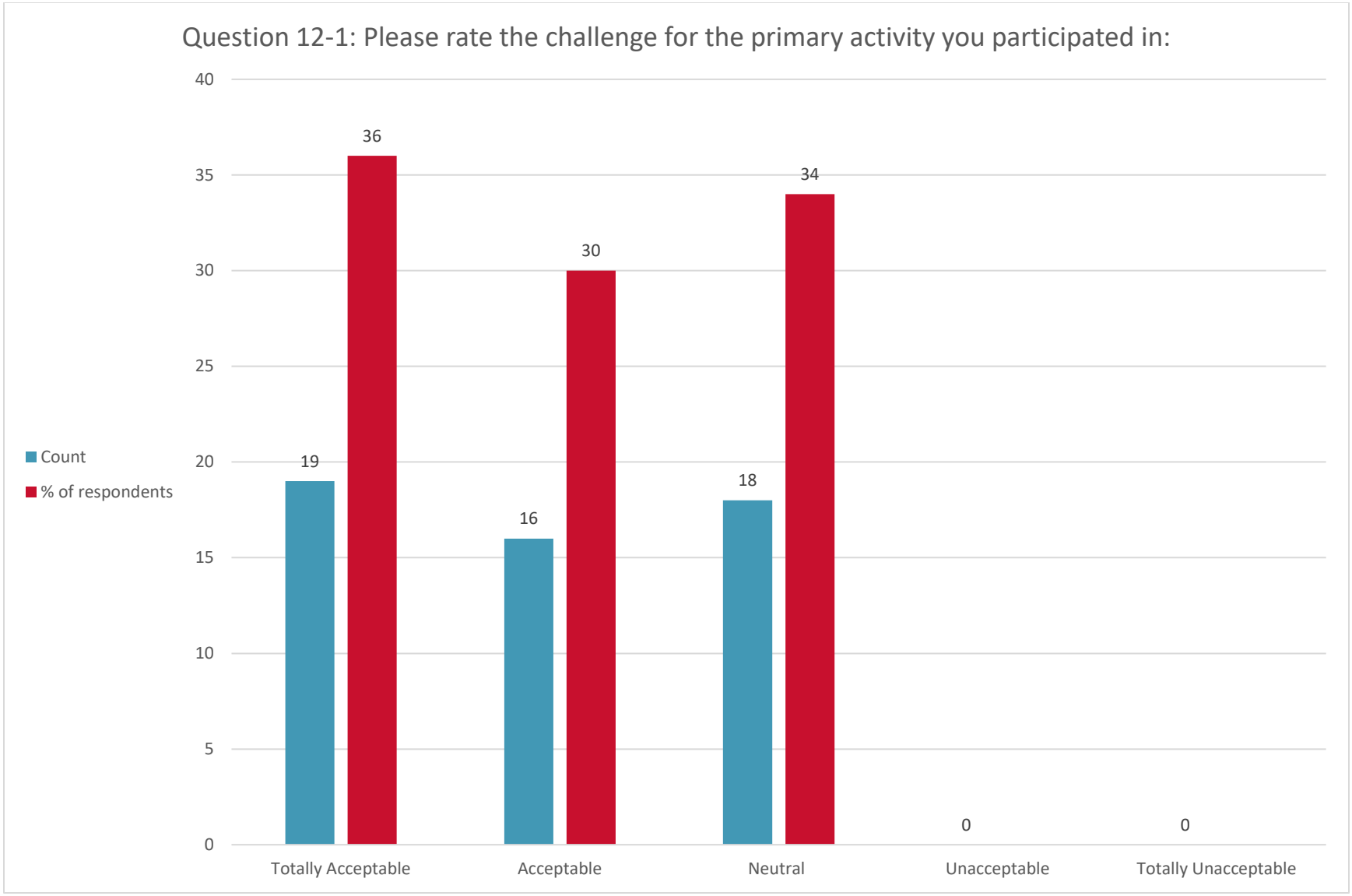


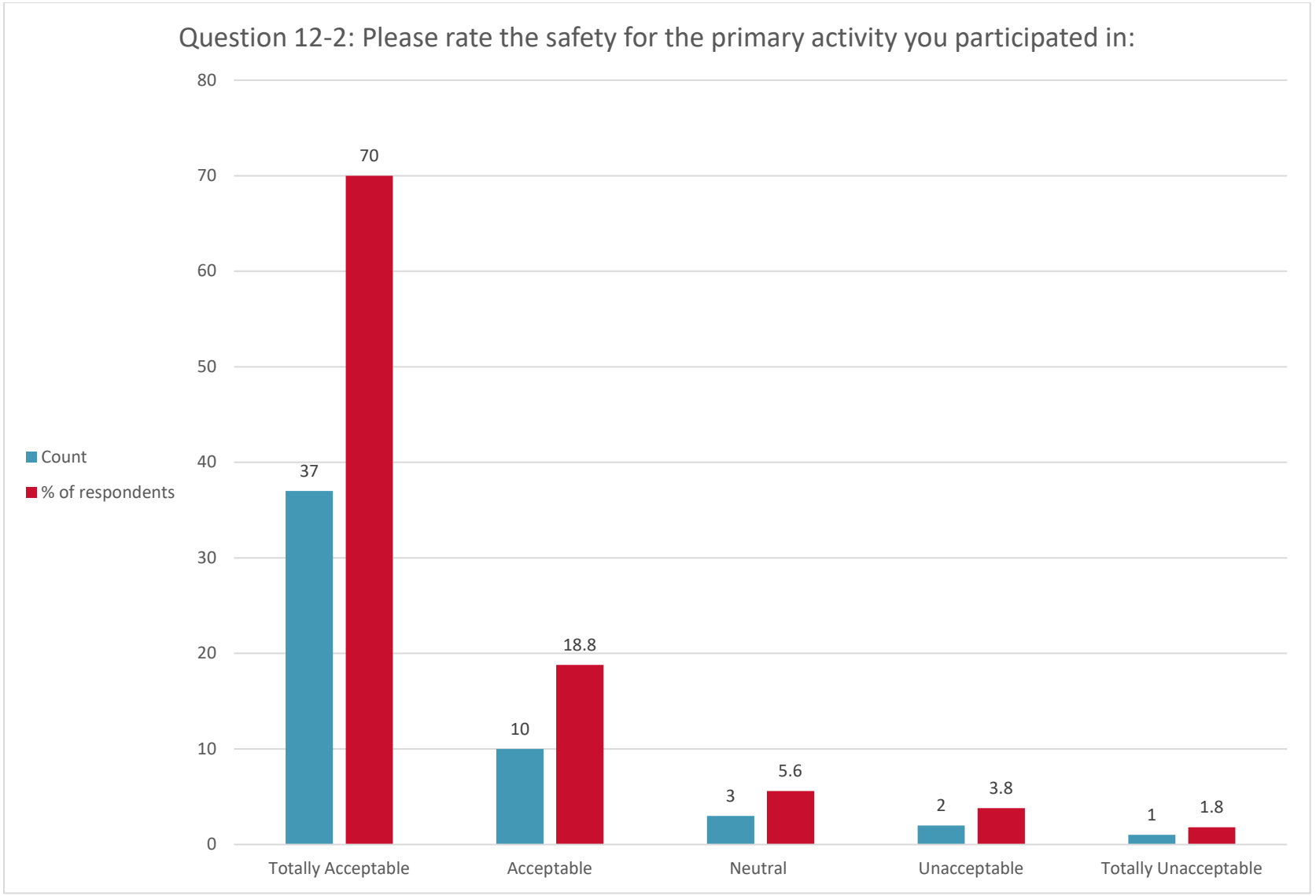


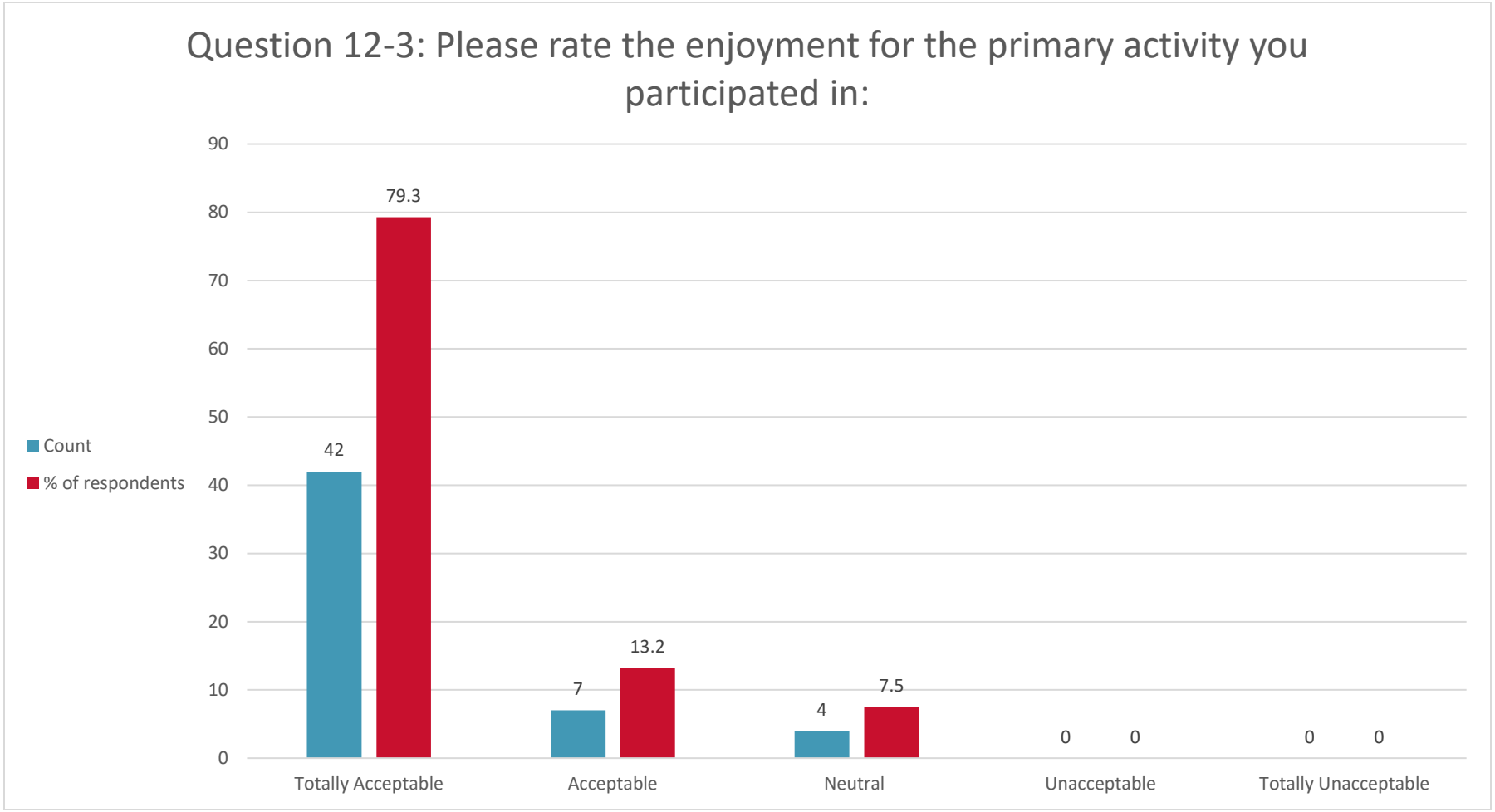
*Other activities included duck feeding, playground, jet skiing, rowing, and wake boarding.

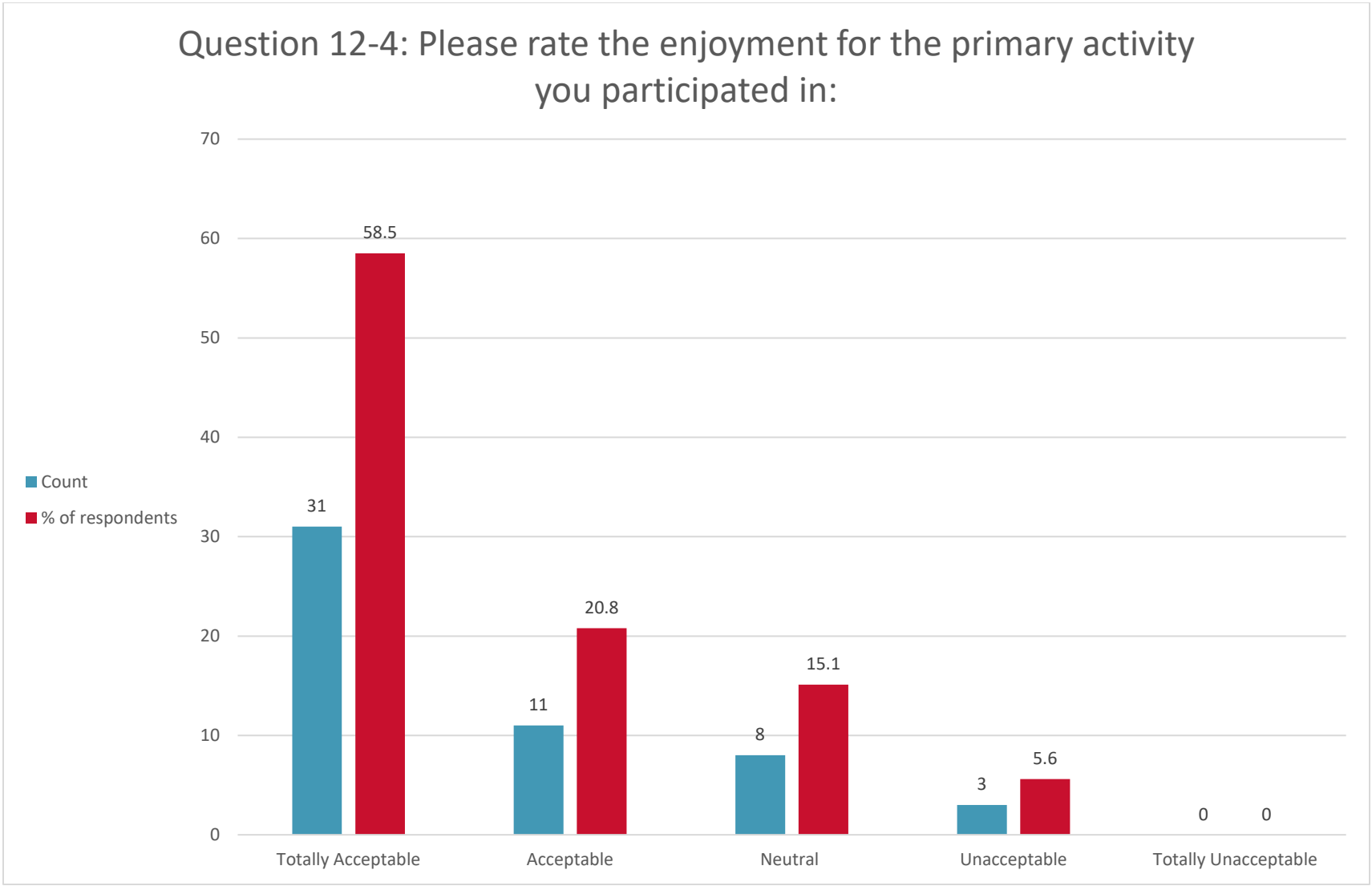


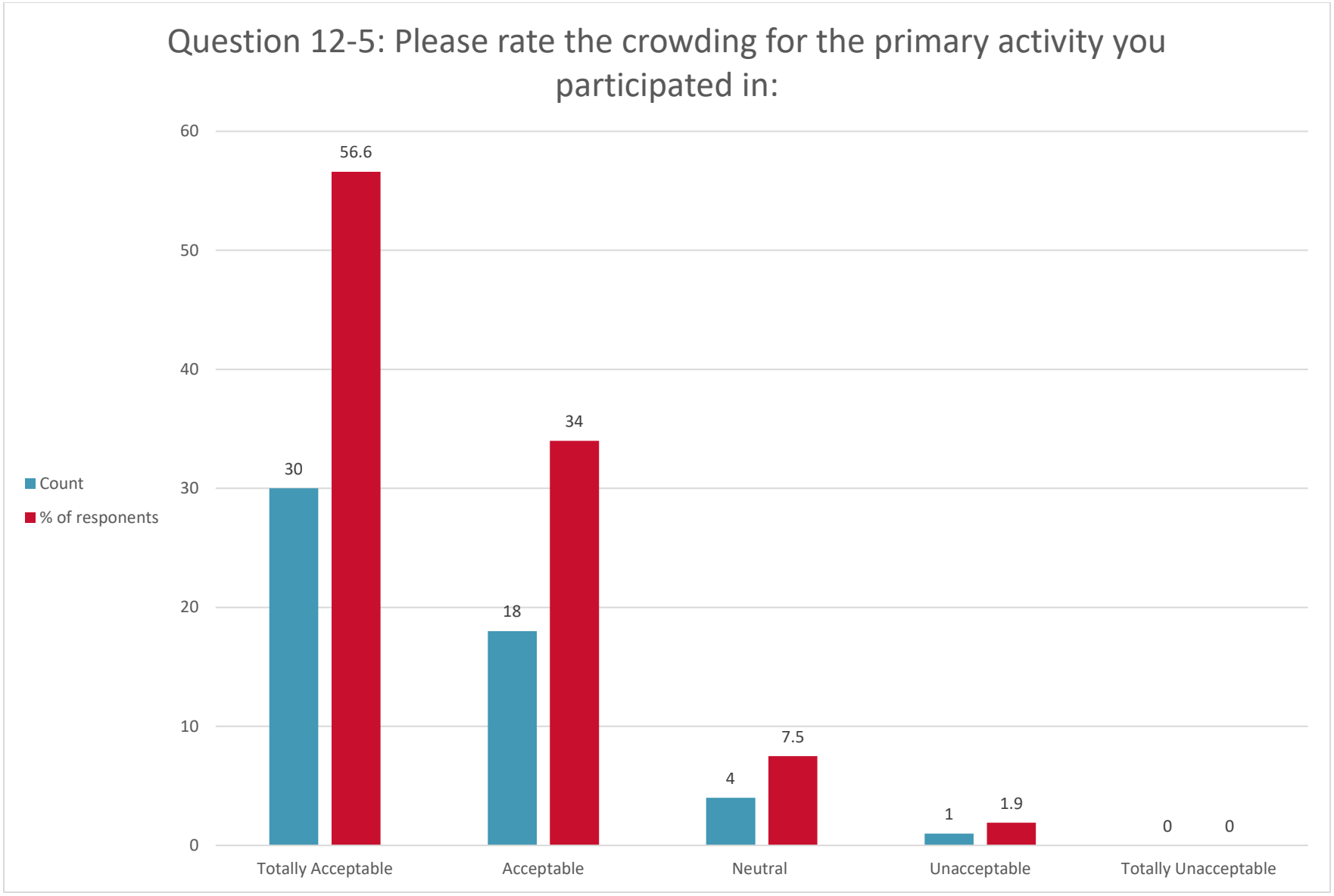
*Other activities included duck feeding, playground, jet skiing, rowing, and wake boarding.

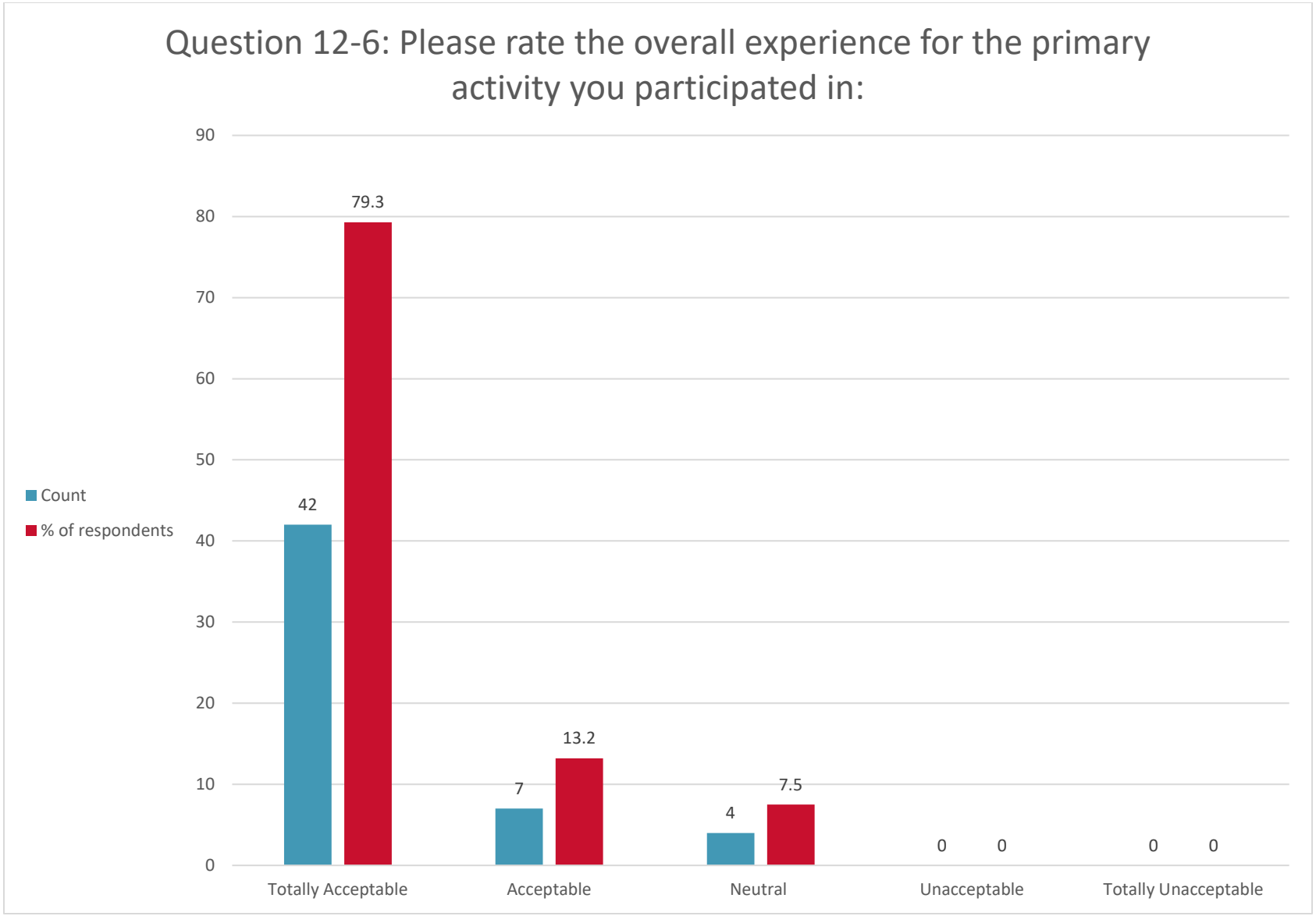

Question 12-1: Please rate the challenge for the primary activity you participated in:
40
35
30
25
20
15
10
5
0
Count
% of respondents
19
36
16
30
18
34
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

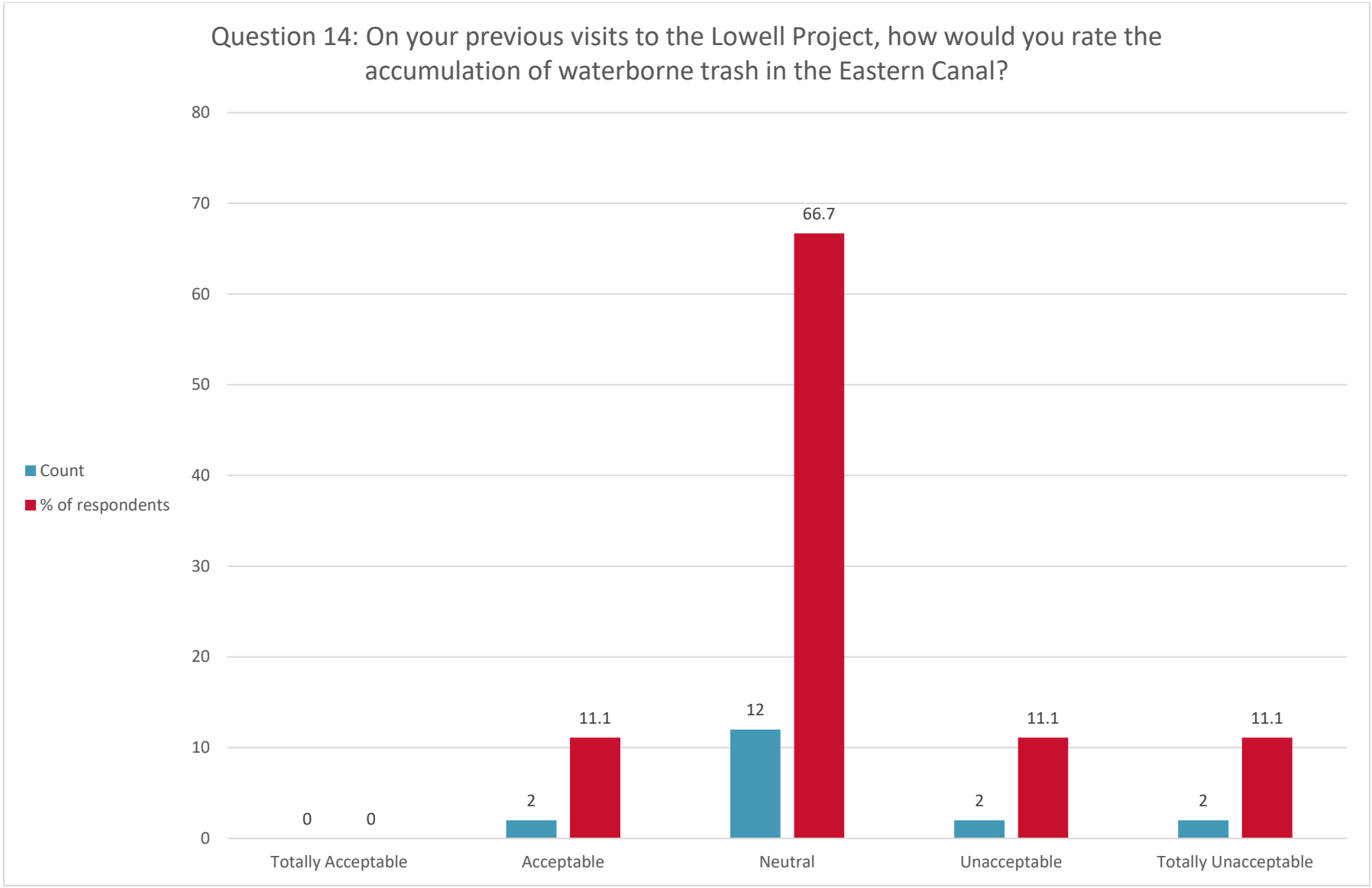

Question 12-2: Please rate the safety for the primary activity you participated in:
80
70
60
50
40
30
20
10
0
Count
% of respondents
37
70
10
18.8
3
5.6
2
3.8
1
1.8
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

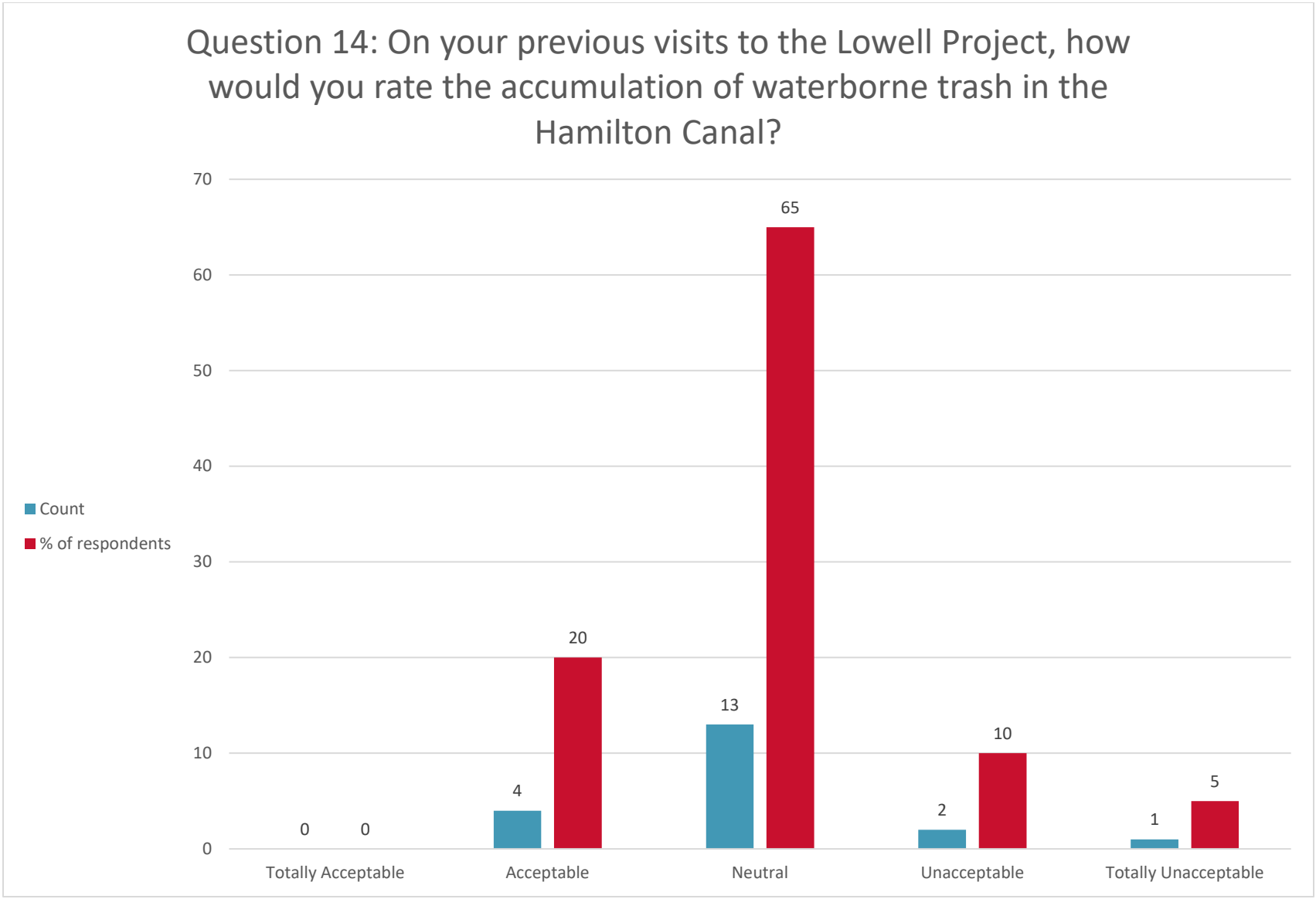

Question 12-3: Please rate the enjoyment for the primary activity you participated in:
Count
% of respondents
90
80
70
60
50
40
30
20
10
0
42
79.3
7
13.2
4
7.5
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

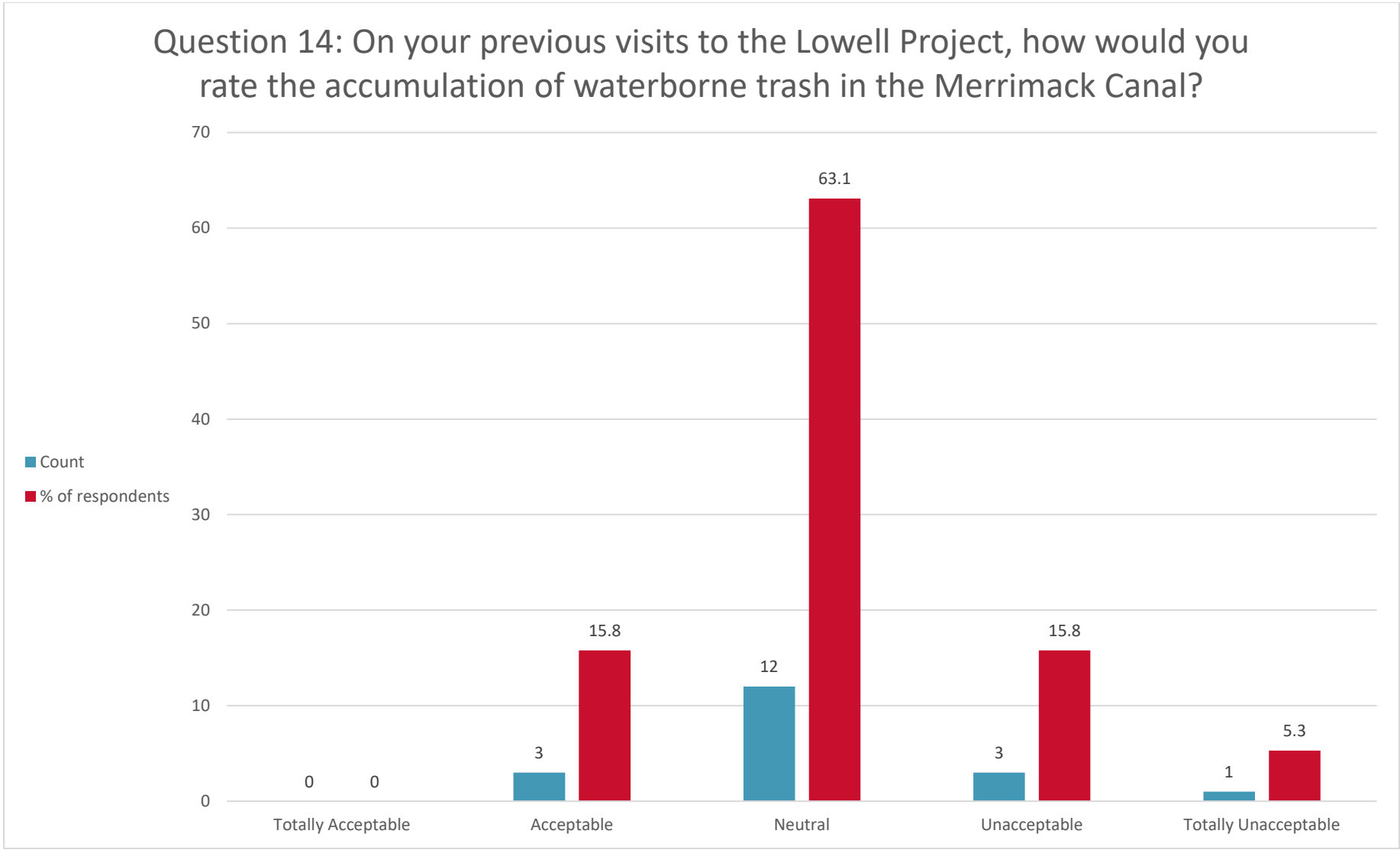

Question 12-4: Please rate the enjoyment for the primary activity you participated in:
70
60
50
40
30
20
10
0
Count
% of respondents
58.5
31
20.8
11
15.1
8
5.6
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

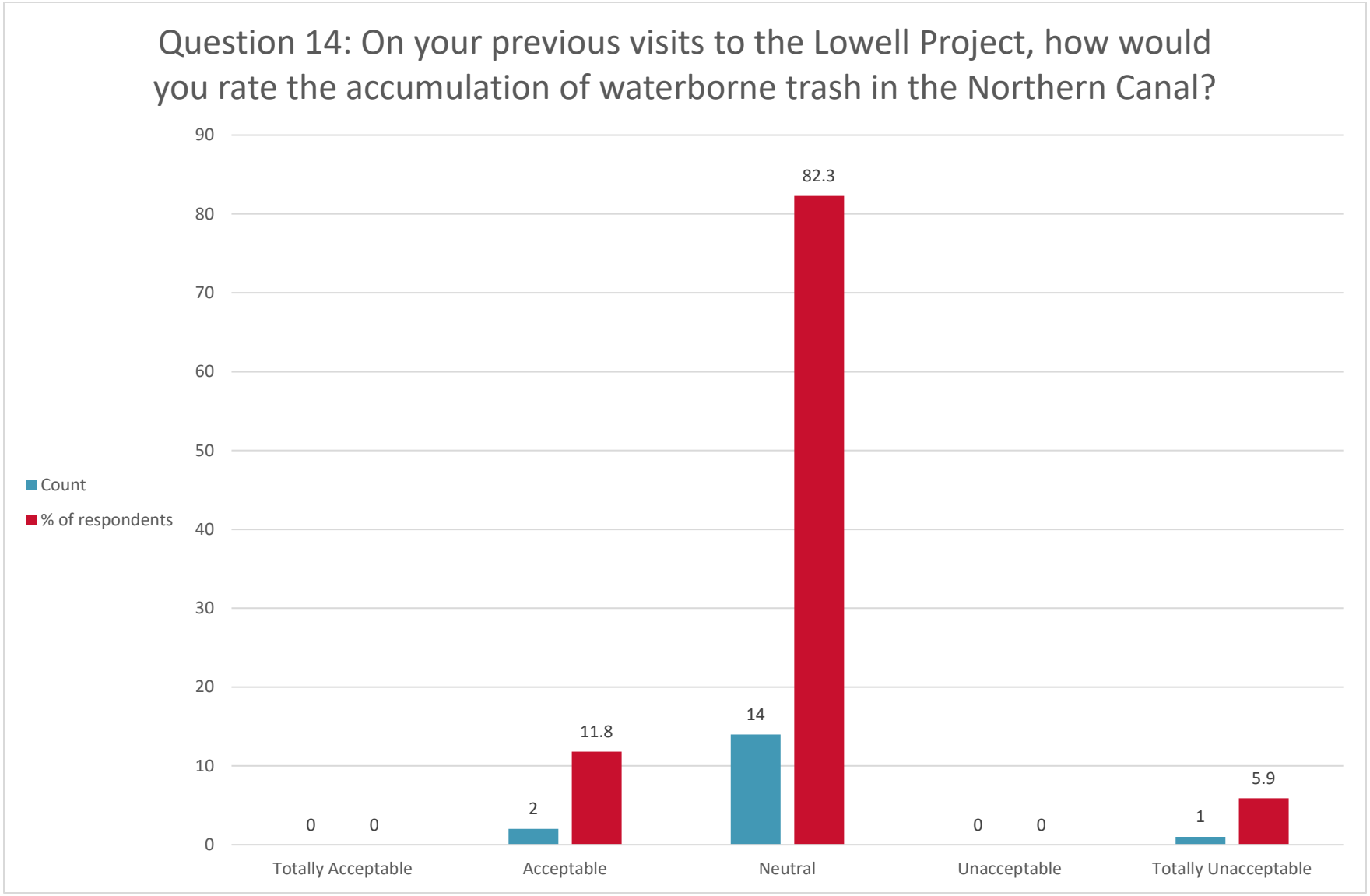

Question 12-5: Please rate the crowding for the primary activity you participated in:
60
50
40
30
20
10
0
56.6
30
34
18
7.5
4
1.9
1
0
0
Count
% of responents
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

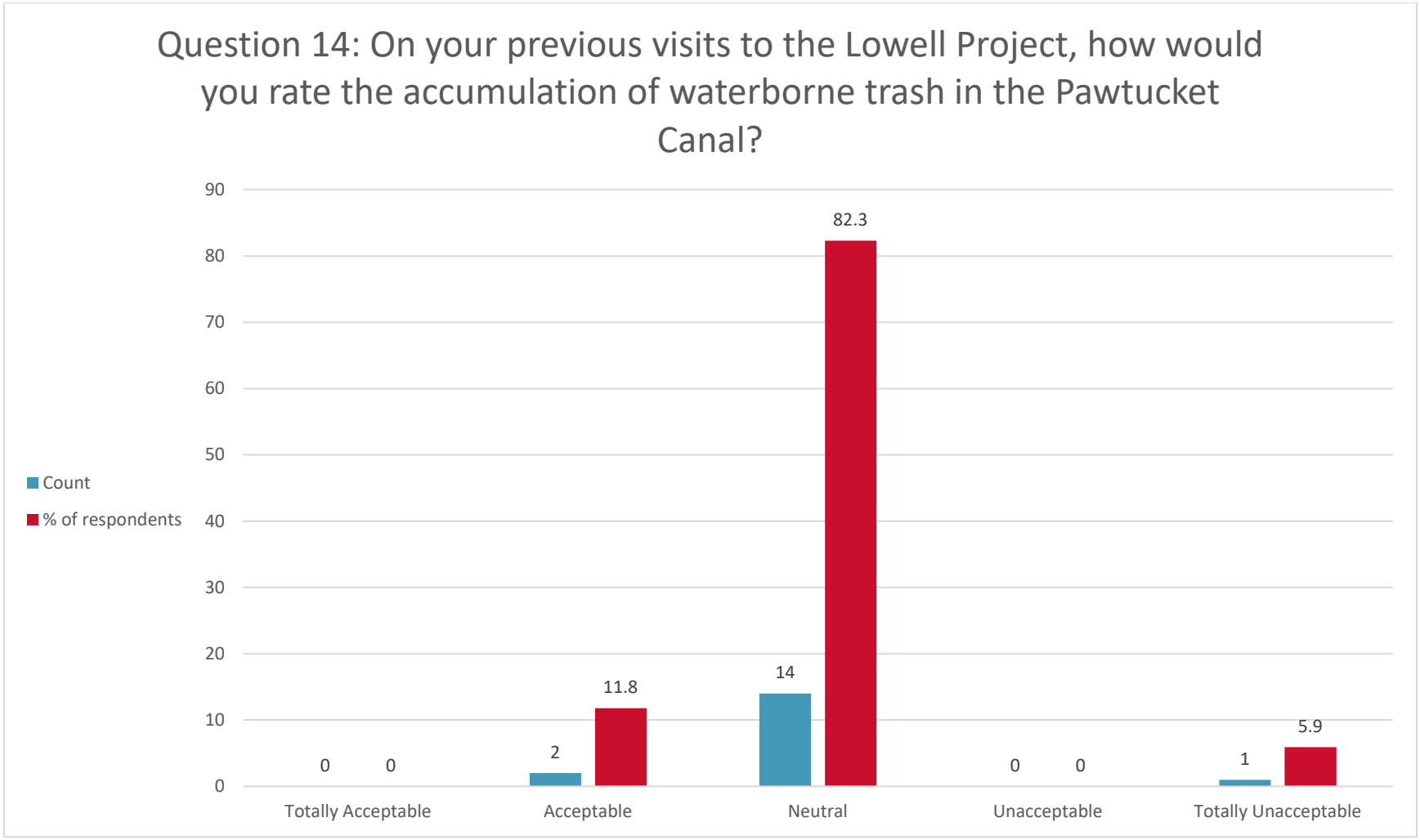

Question 12-6: Please rate the overall experience for the primary activity you participated in:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
42
79.3
7
13.2
4
7.5
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

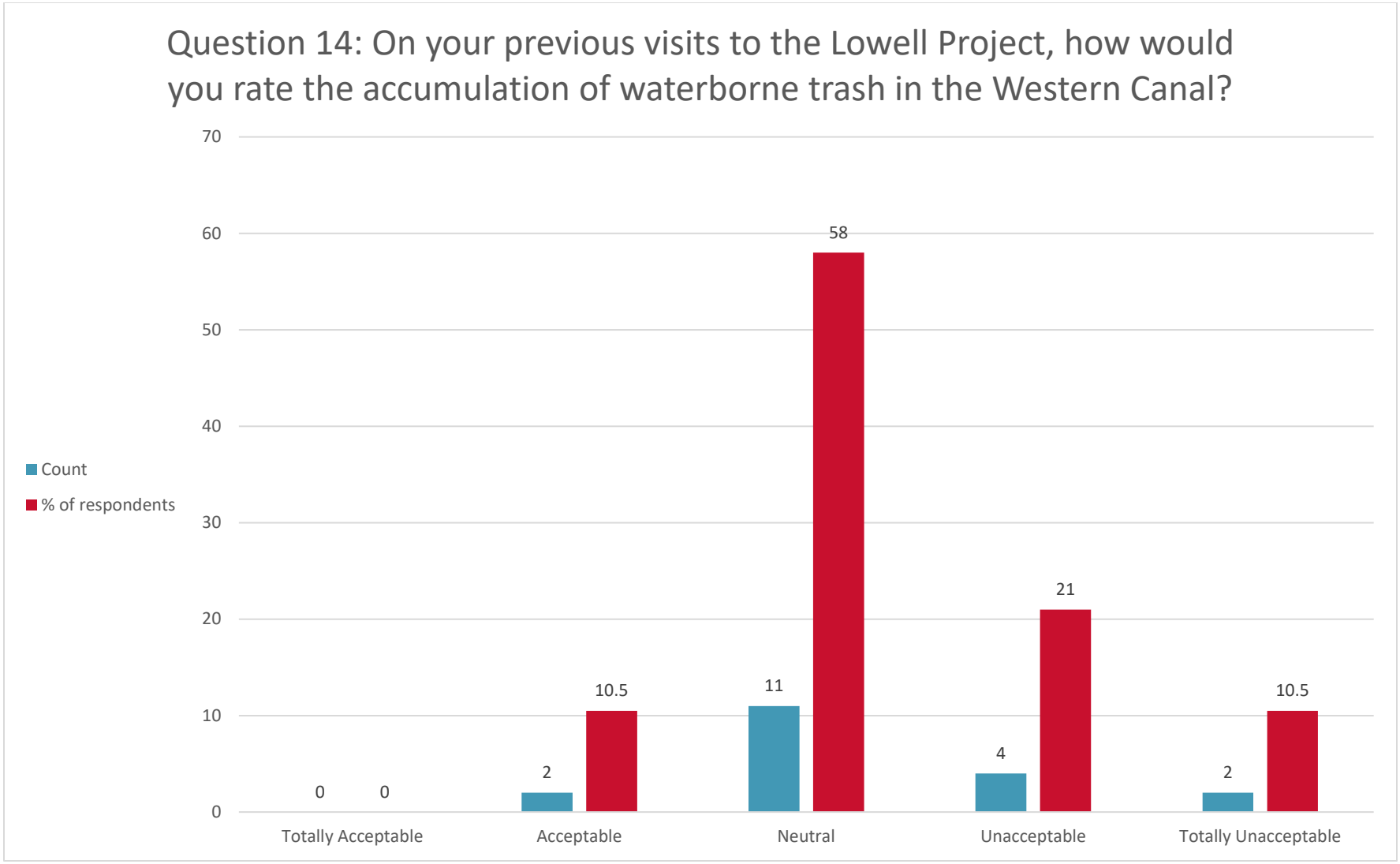

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Eastern Canal?
80
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
2
11.1
12
66.7
2
11.1
2
11.1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

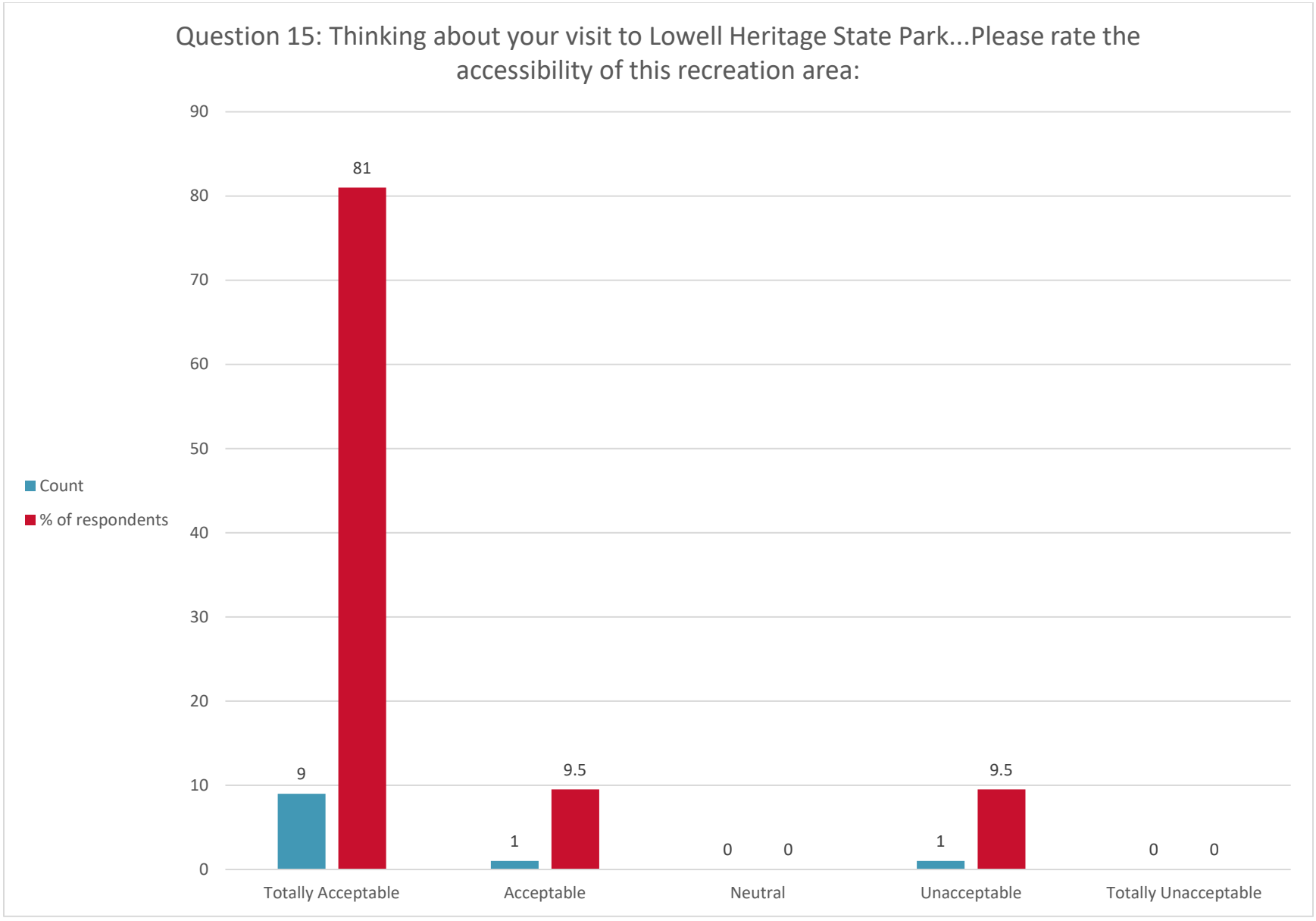

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Hamilton Canal?
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
4
20
13
65
2
10
1
5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

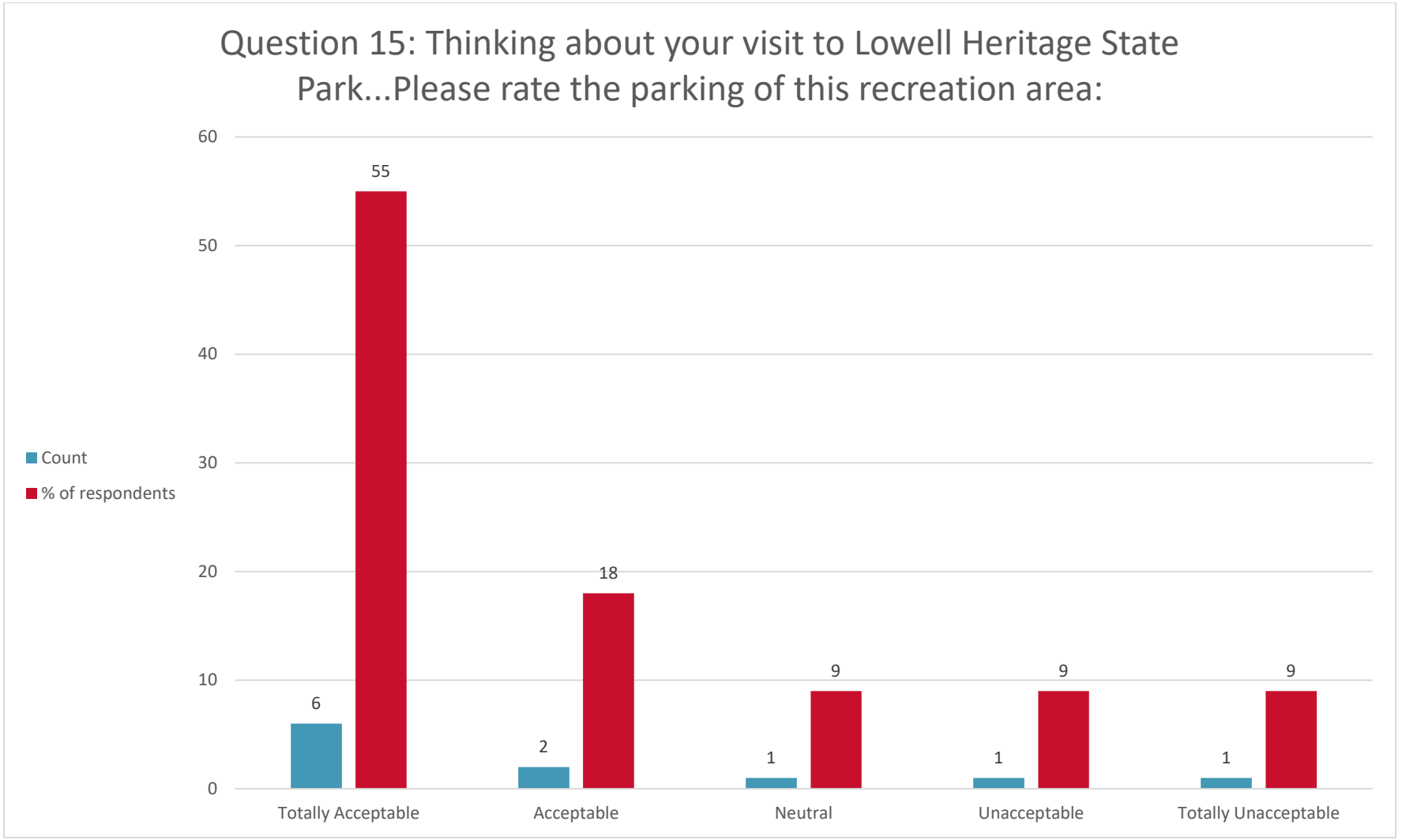

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Merrimack Canal?
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
3
15.8
12
63.1
3
15.8
1
5.3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

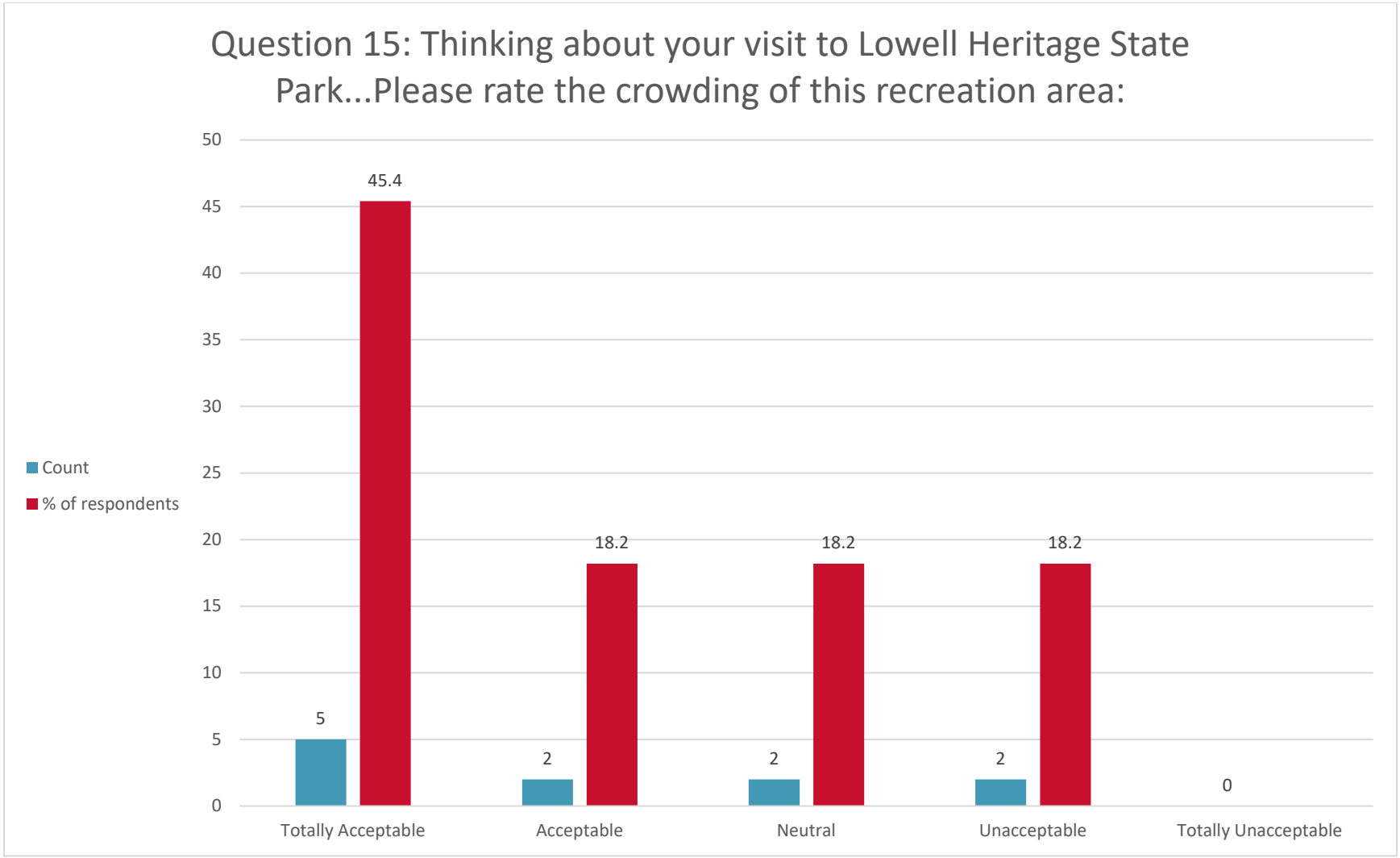

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Northern Canal?
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
2
11.8
14
82.3
0
0
1
5.9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

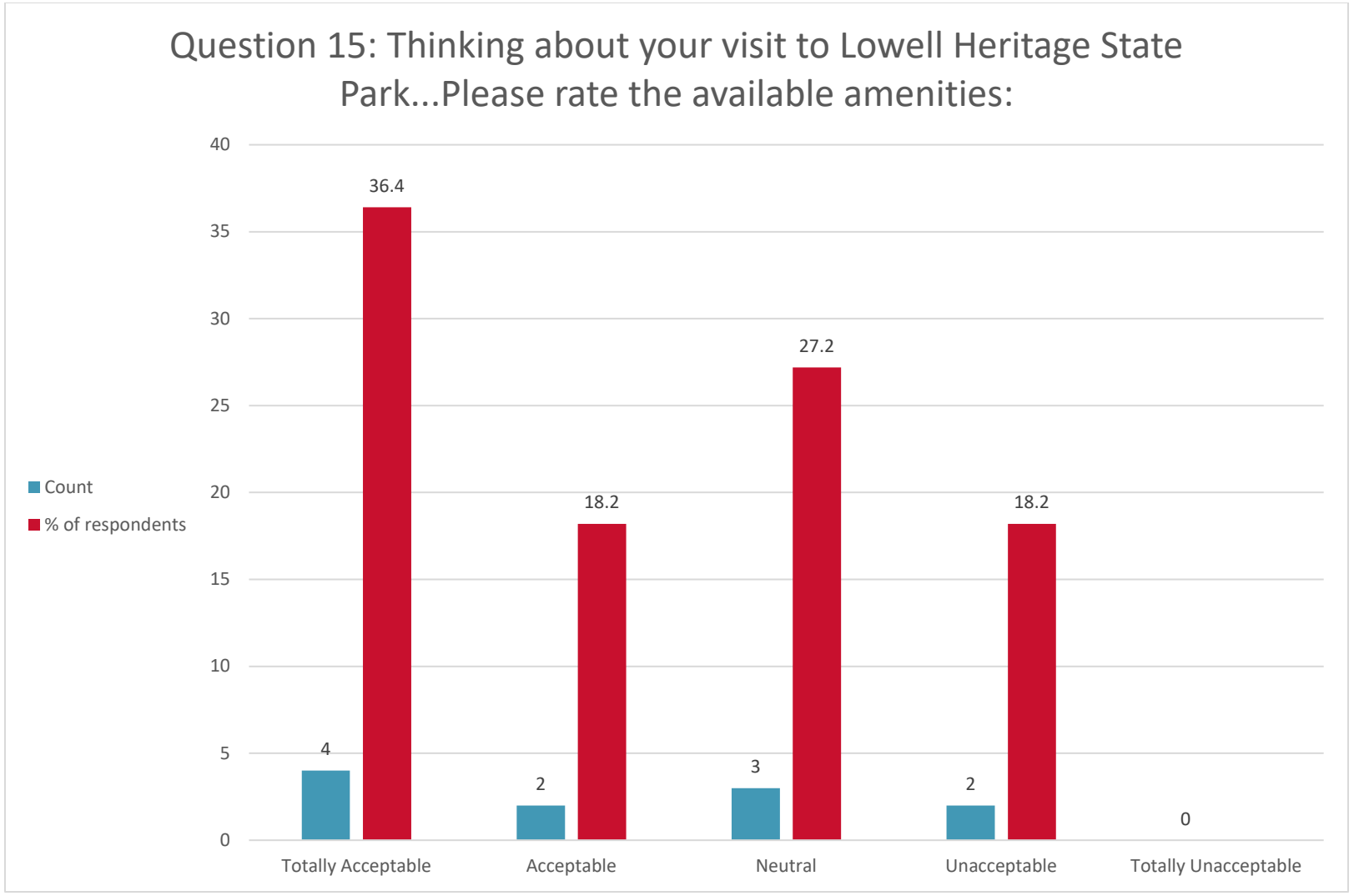

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Pawtucket Canal?
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
2
11.8
14
82.3
0
0
1
5.9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

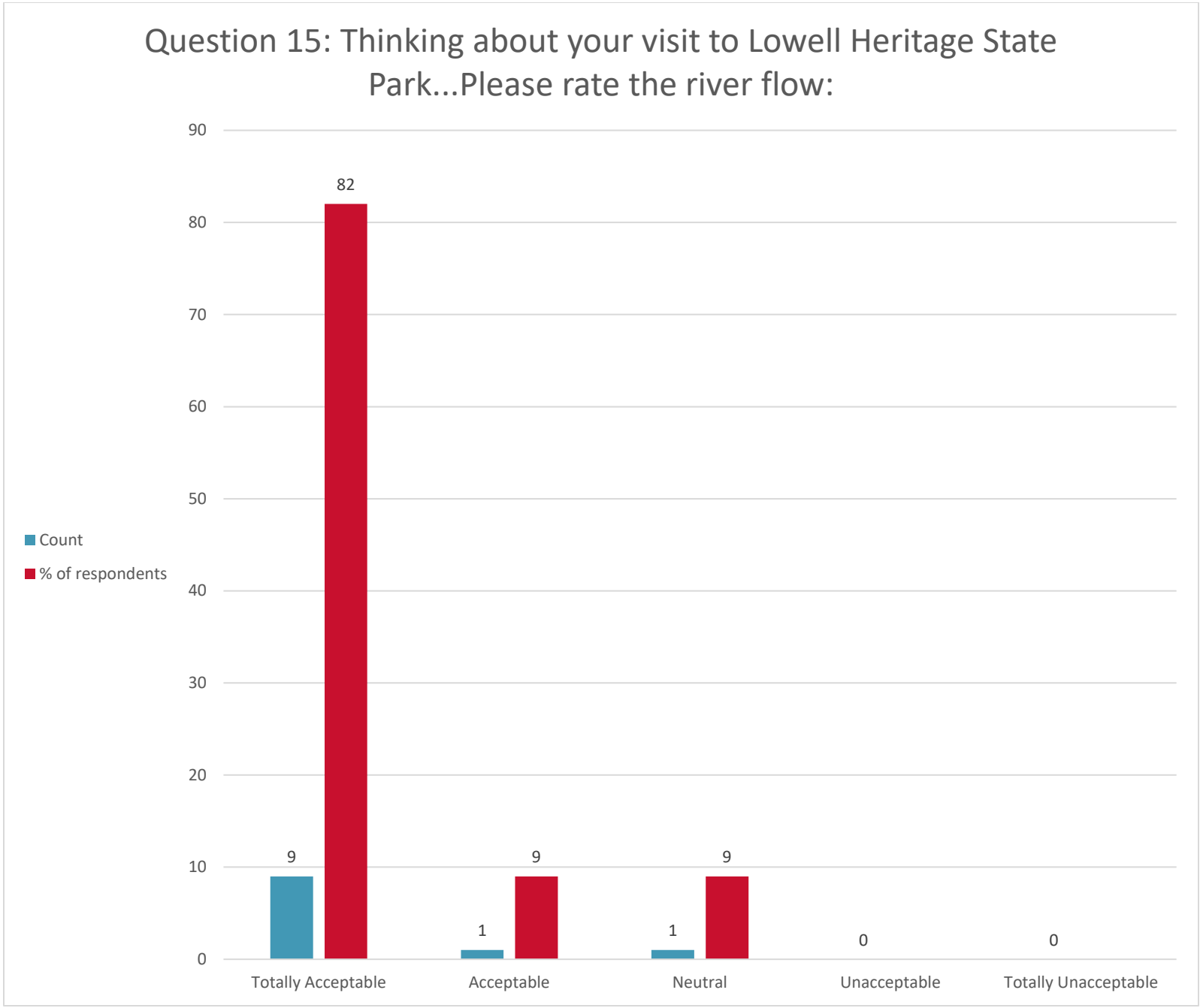

Question 14: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Western Canal?
70
60
50
40
30
20
10
0
Count
% of respondents
0
0
2
10.5
11
58
4
21
2
10.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

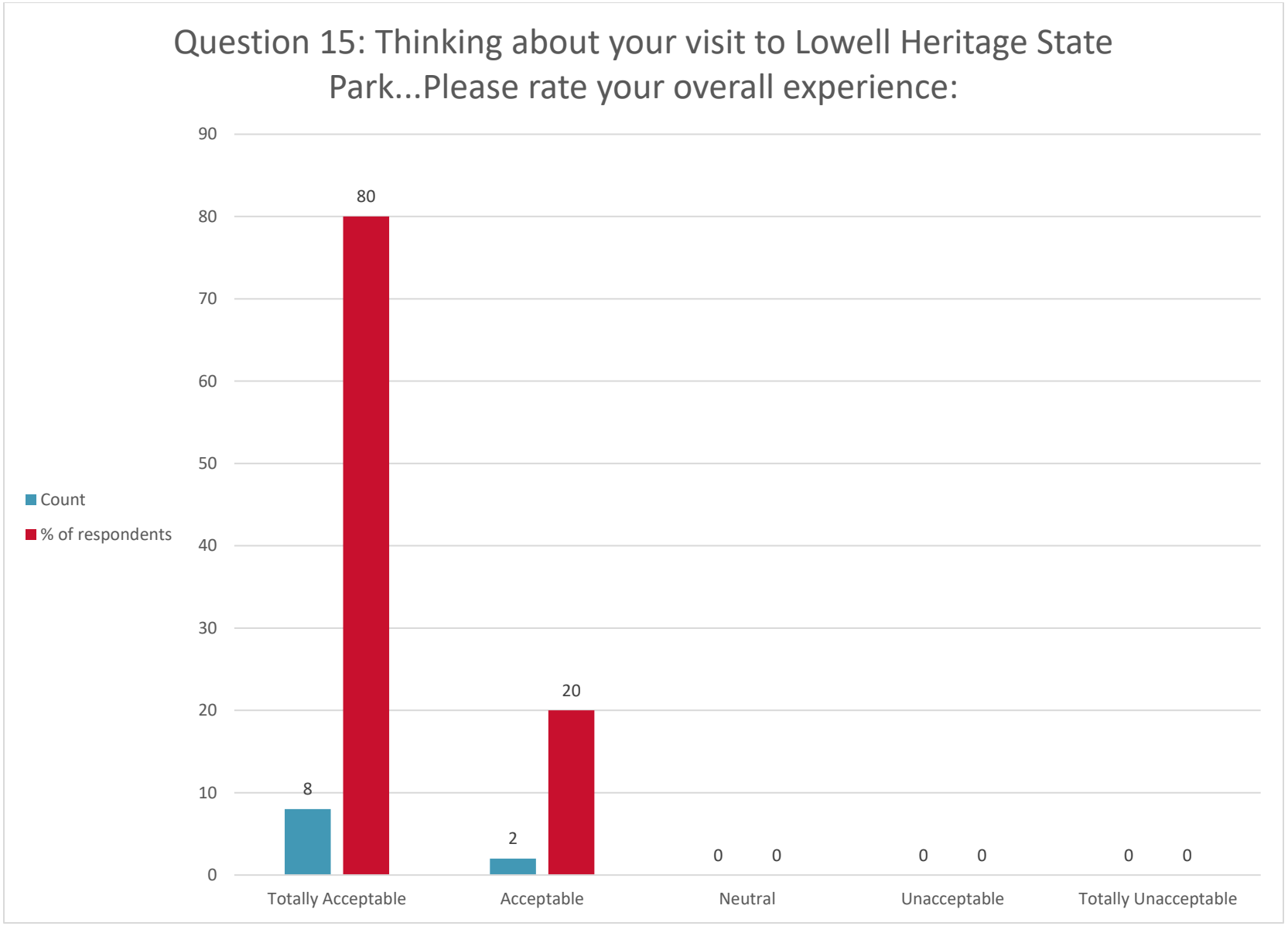

Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate the accessibility of this recreation area:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
81
9
9.5
1
0
0
9.5
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

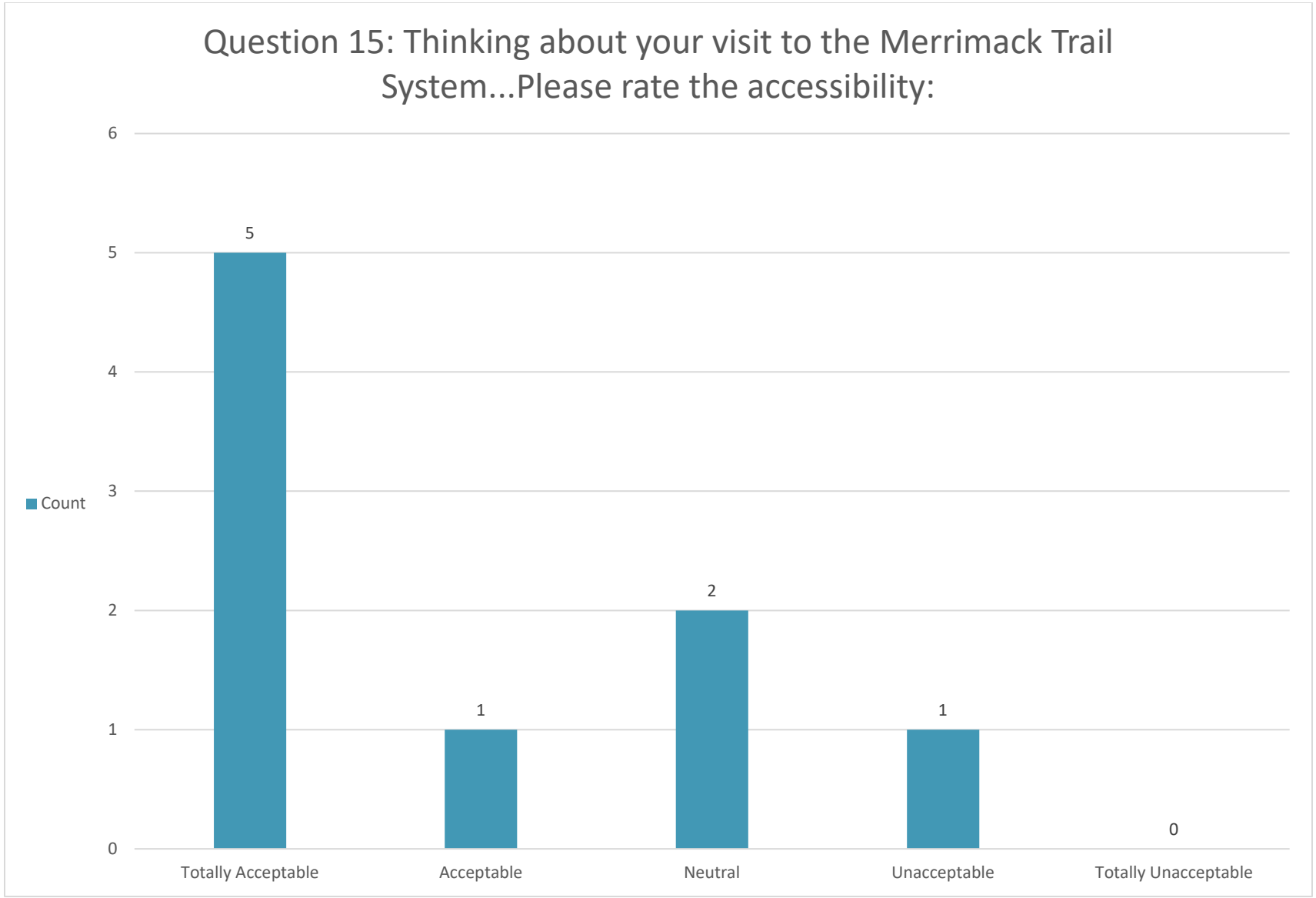

Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate the parking of this recreation area:
60
50
40
30
20
10
0
Count
% of respondents
55
18
9
9
9
6
2
1
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate the crowding of this recreation area:
50
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
45.4
18.2
18.2
18.2
5
2
2
2
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

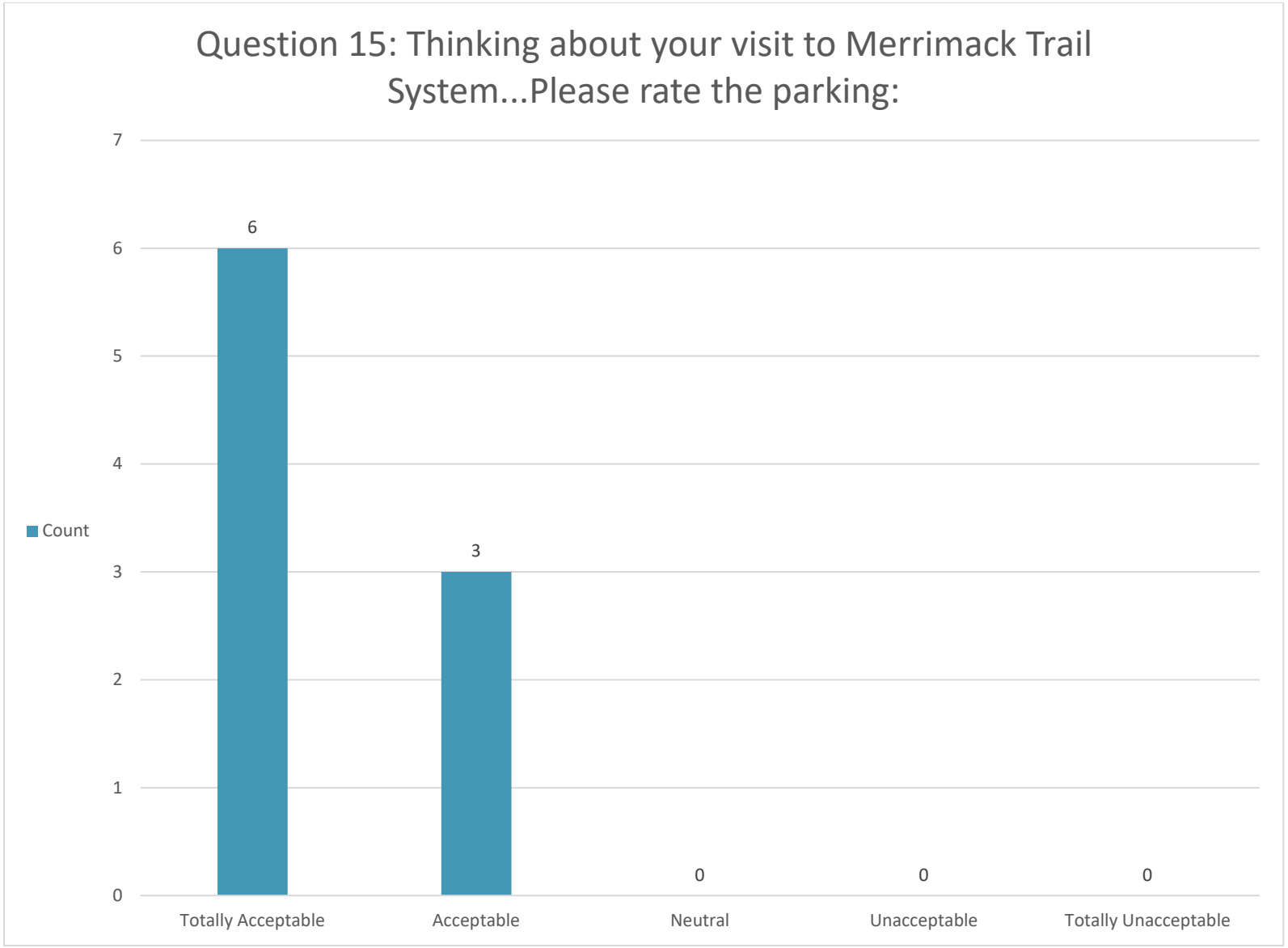

Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate the available amenities:
40
35
30
25
20
15
10
5
0
Count
% of respondents
36.4
18.2
27.2
18.2
4
2
3
2
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate the river flow:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
82
9
9
1
9
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

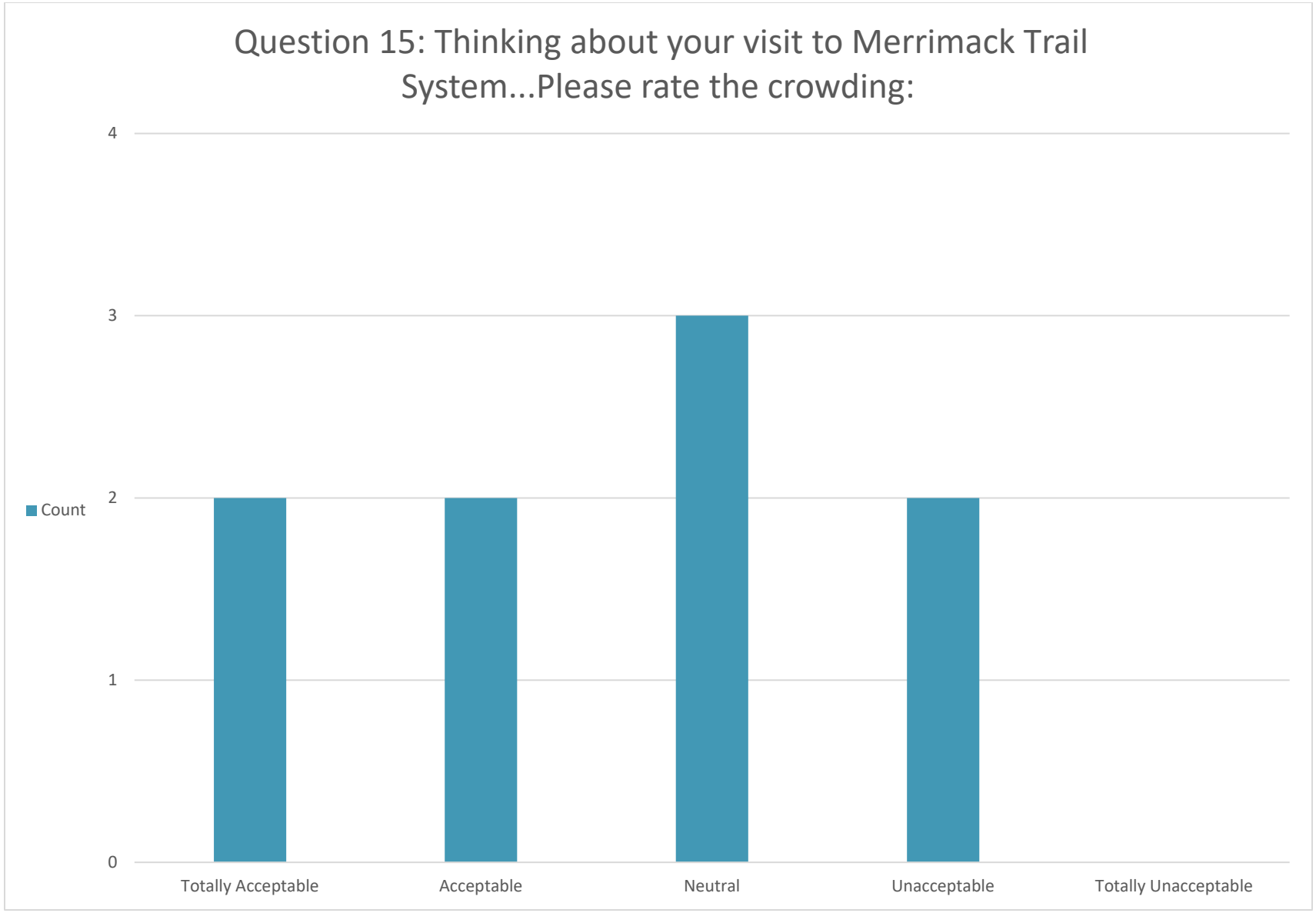

Question 15: Thinking about your visit to Lowell Heritage State Park...Please rate your overall experience:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
80
20
8
2
0
0
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable



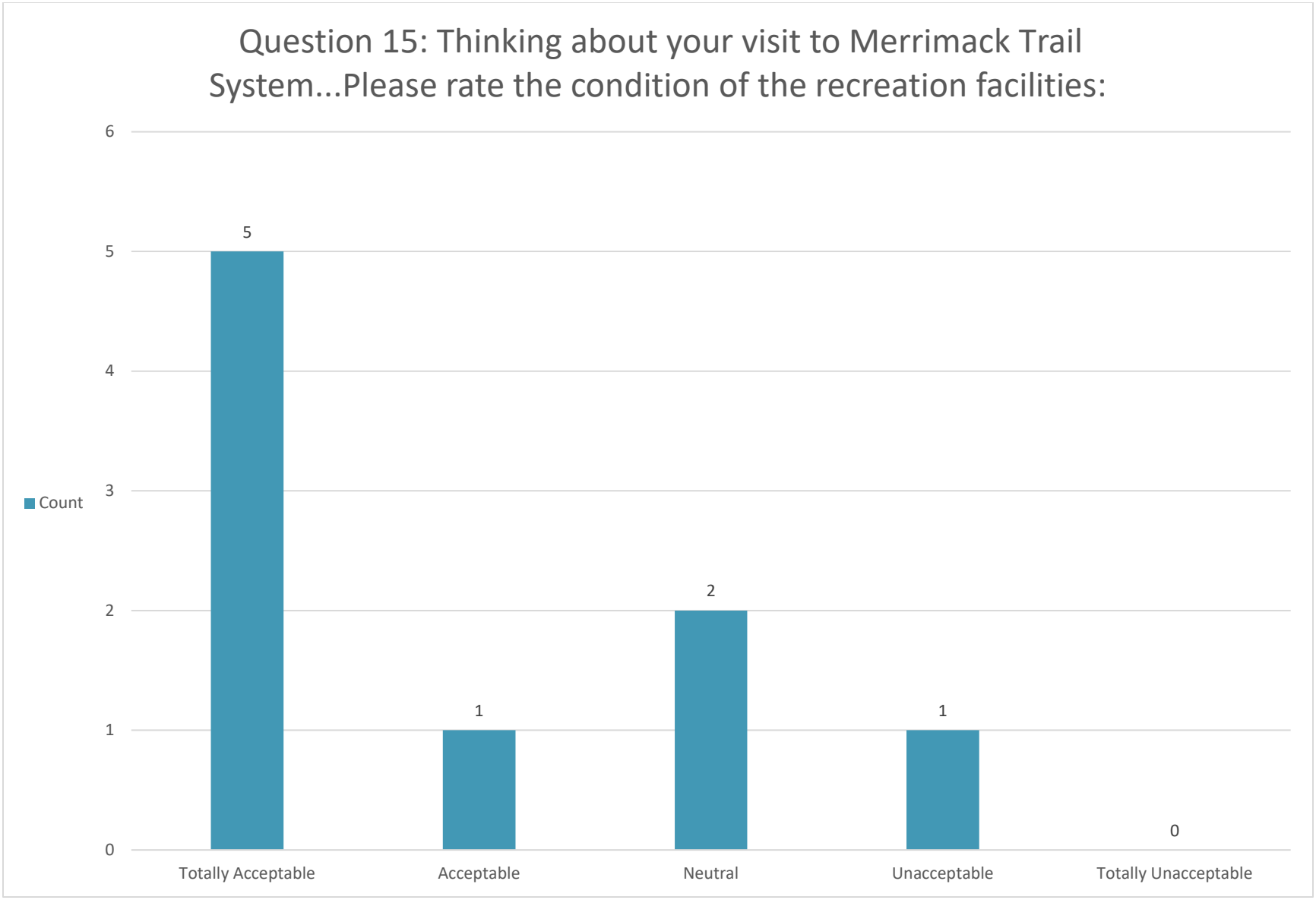
*Percentages not shown for respondent counts under ten.



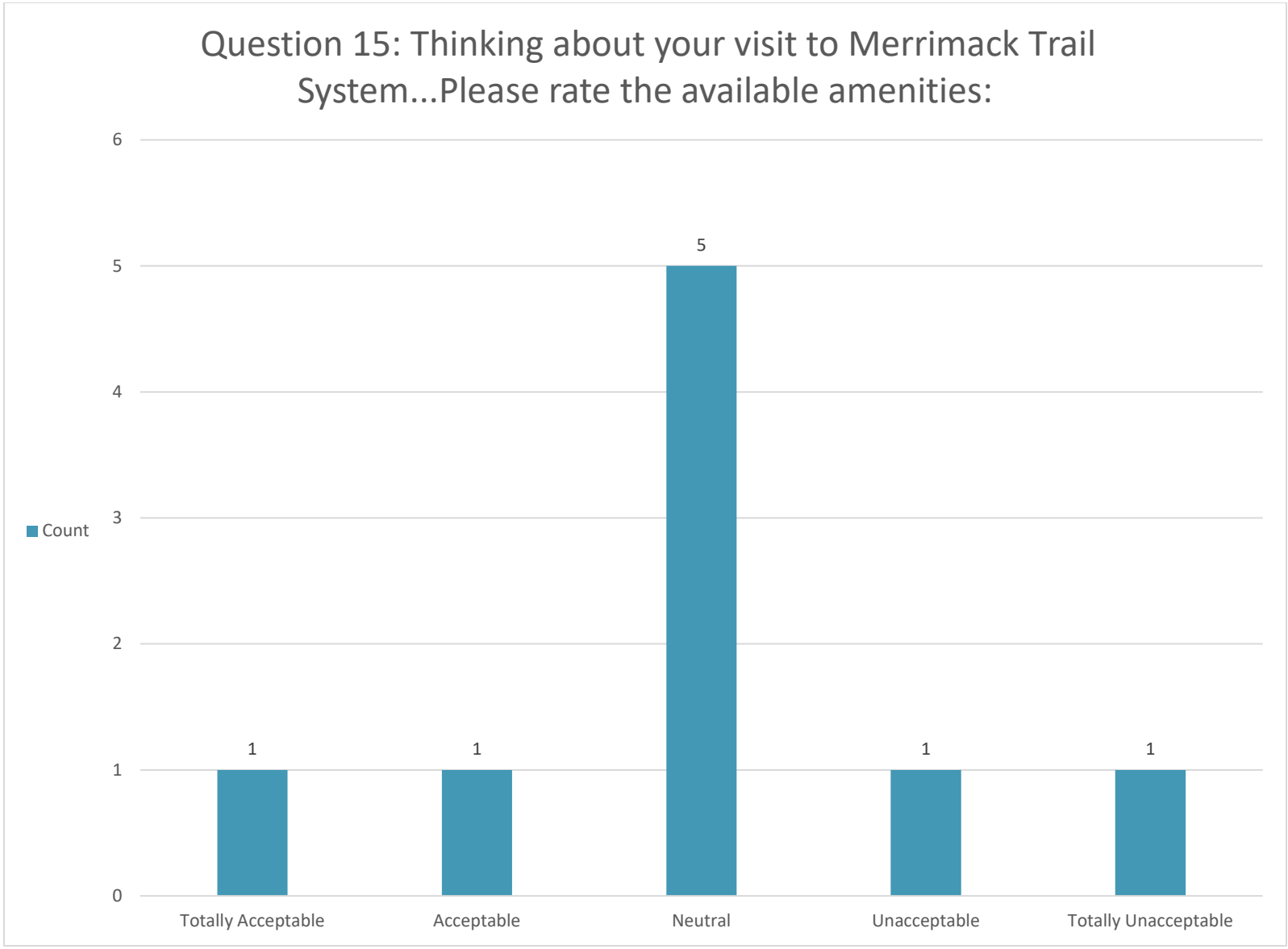
*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



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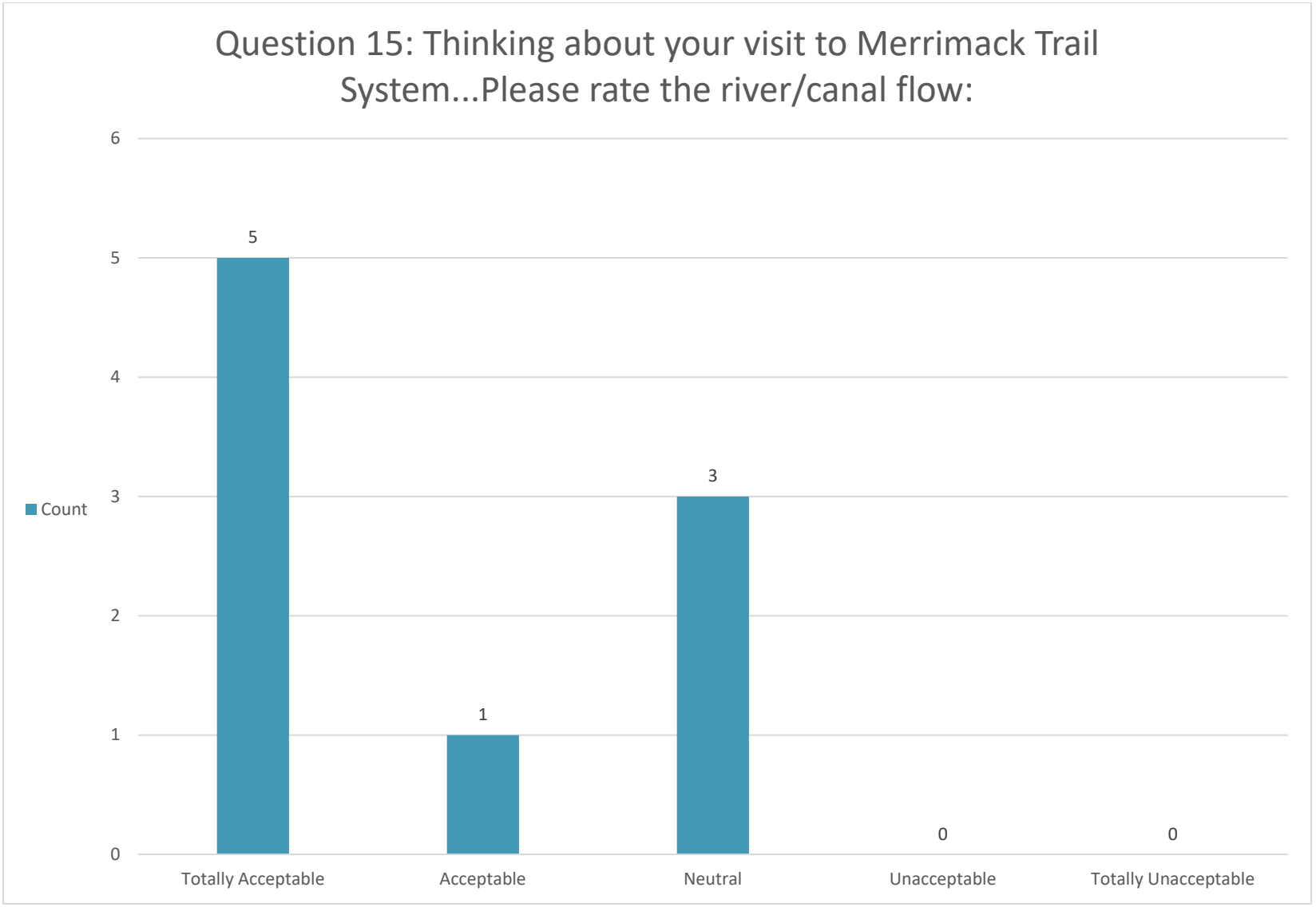

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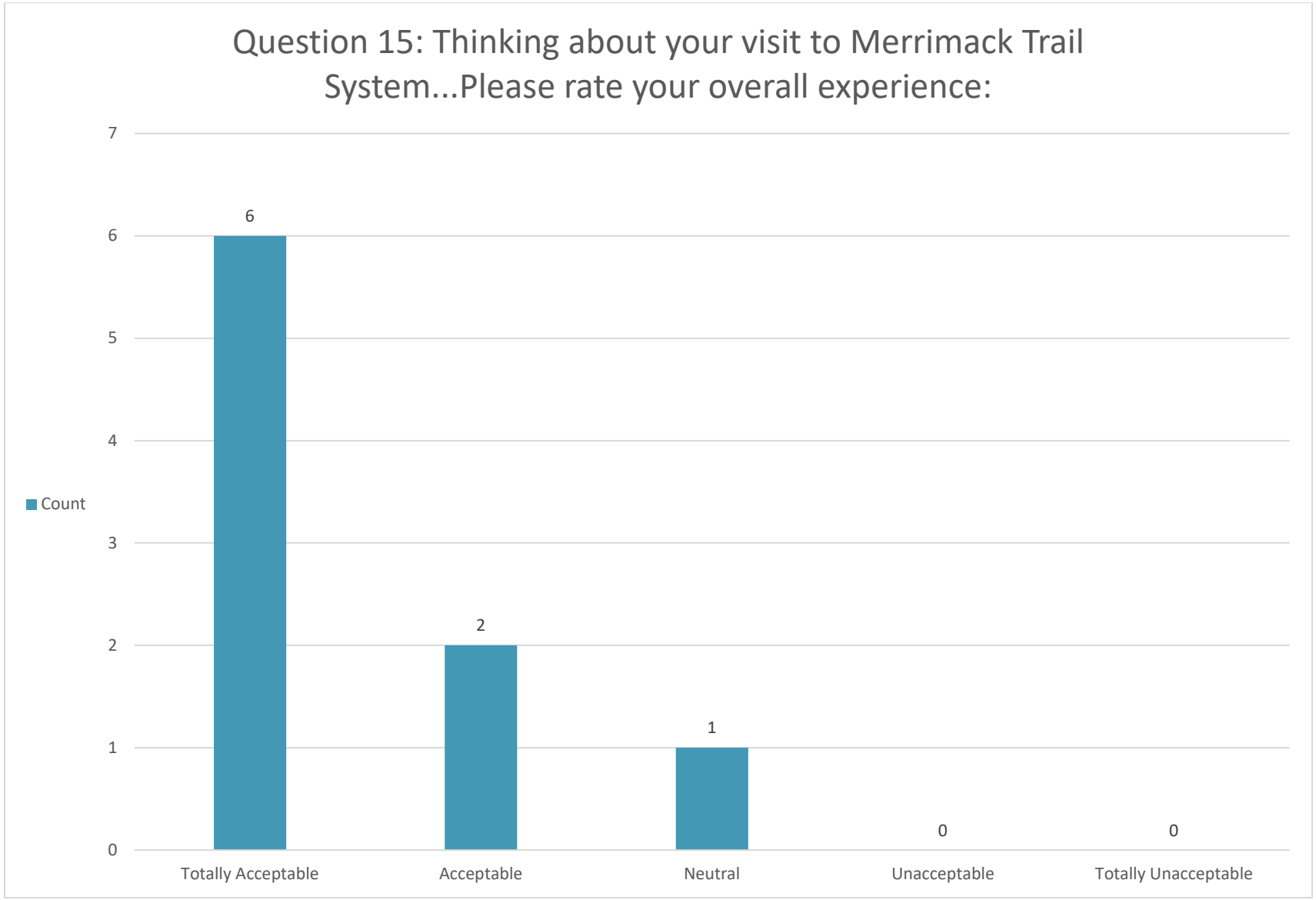

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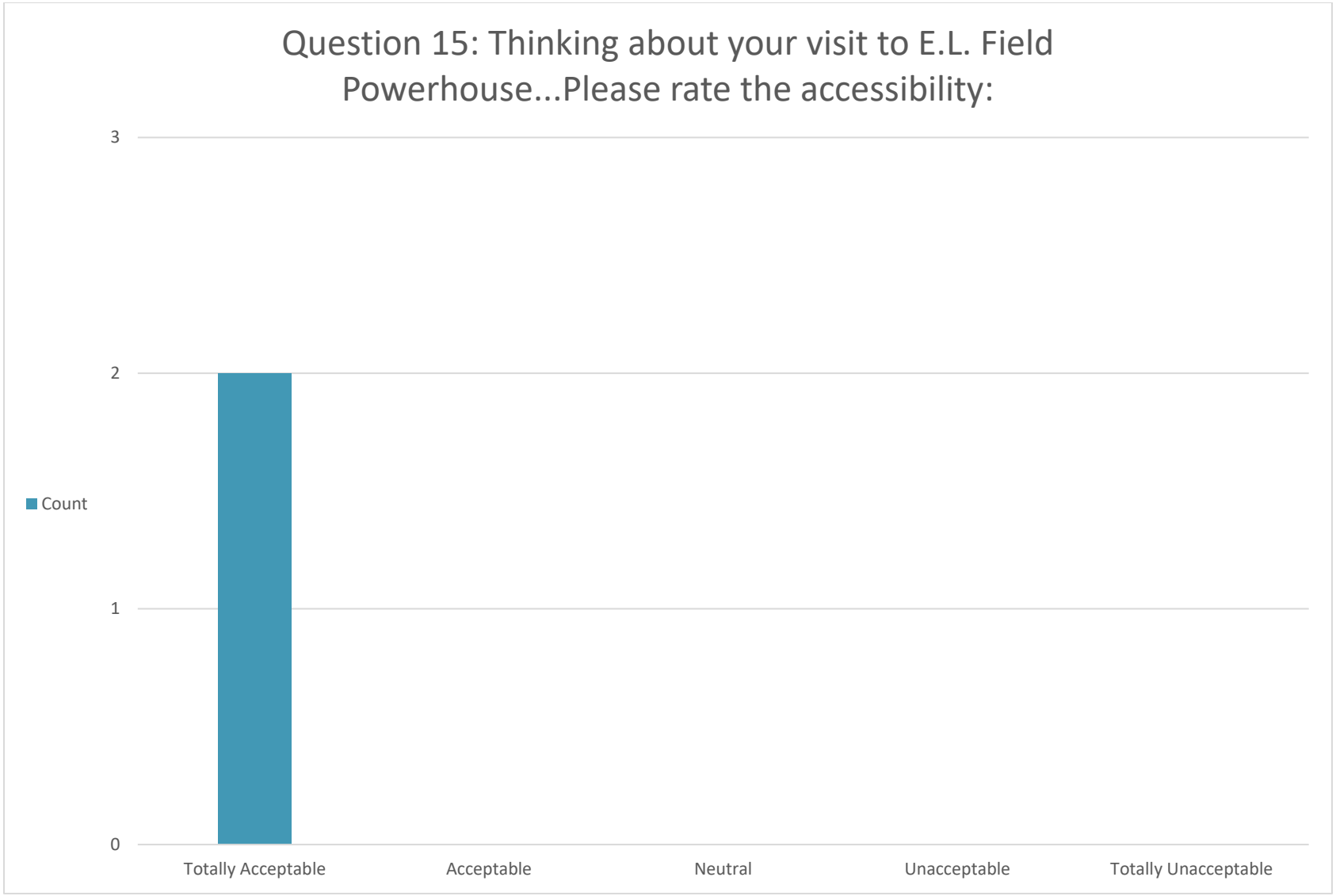

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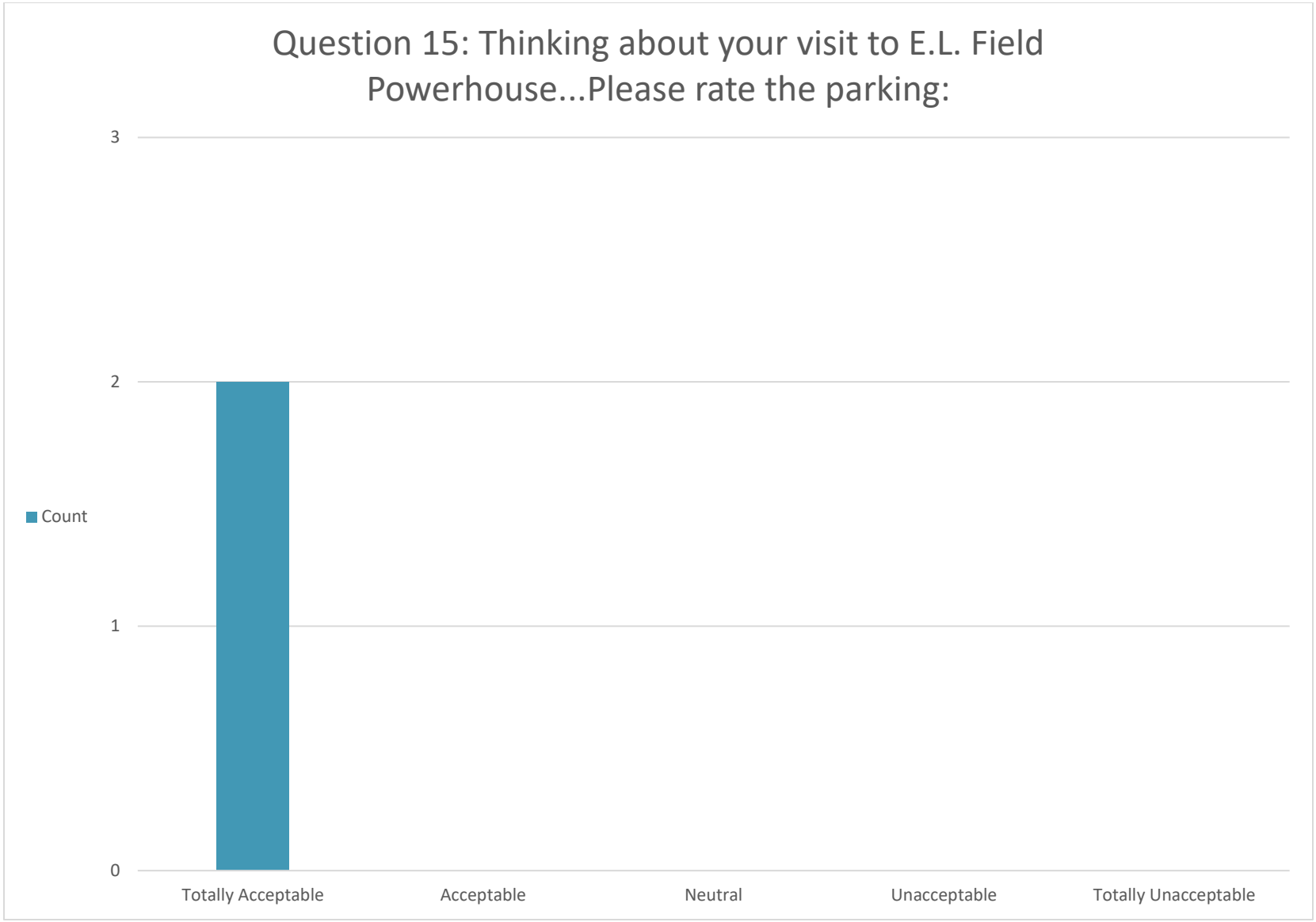

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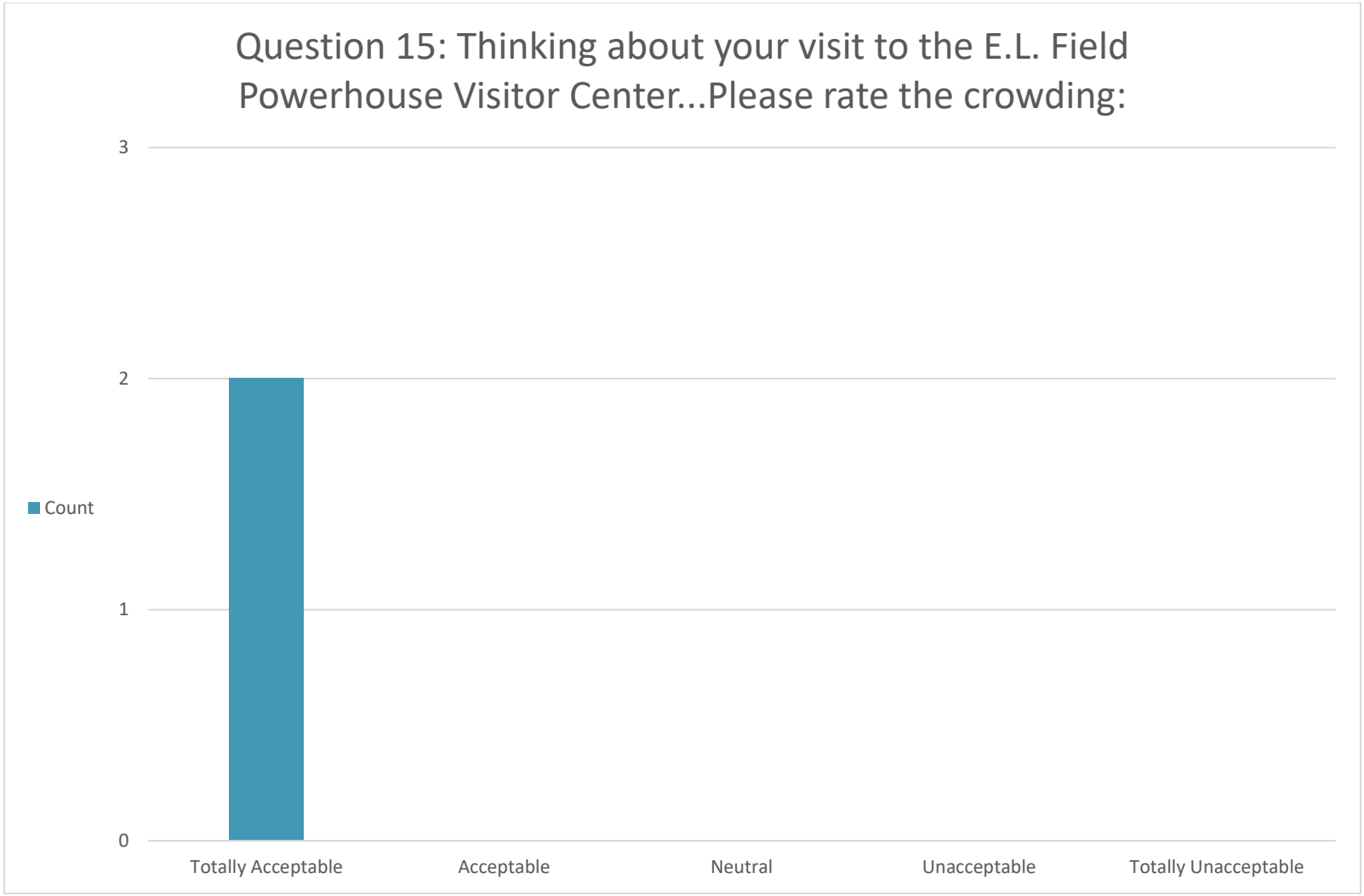
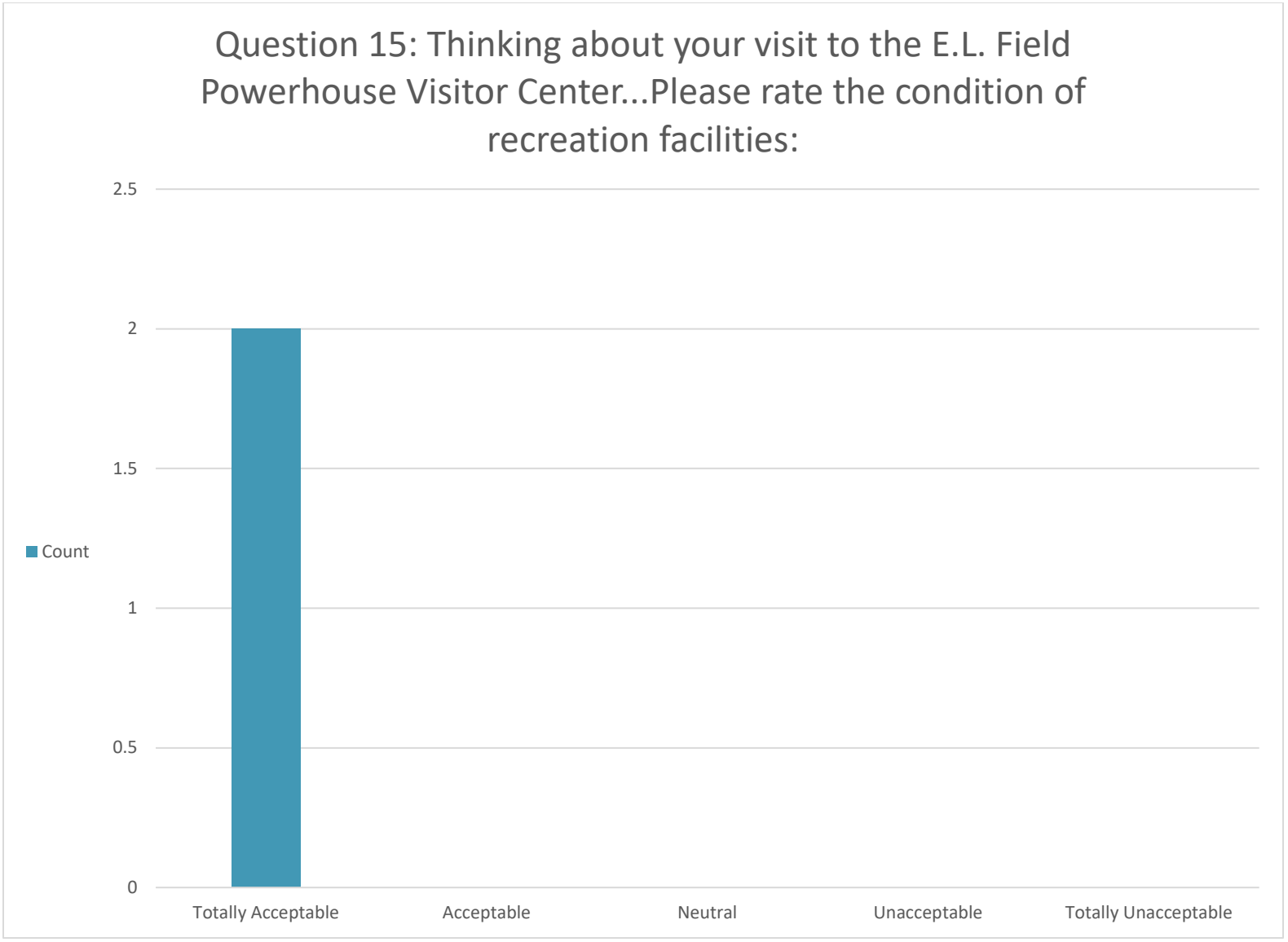


*Percentages not shown for respondent counts under ten.



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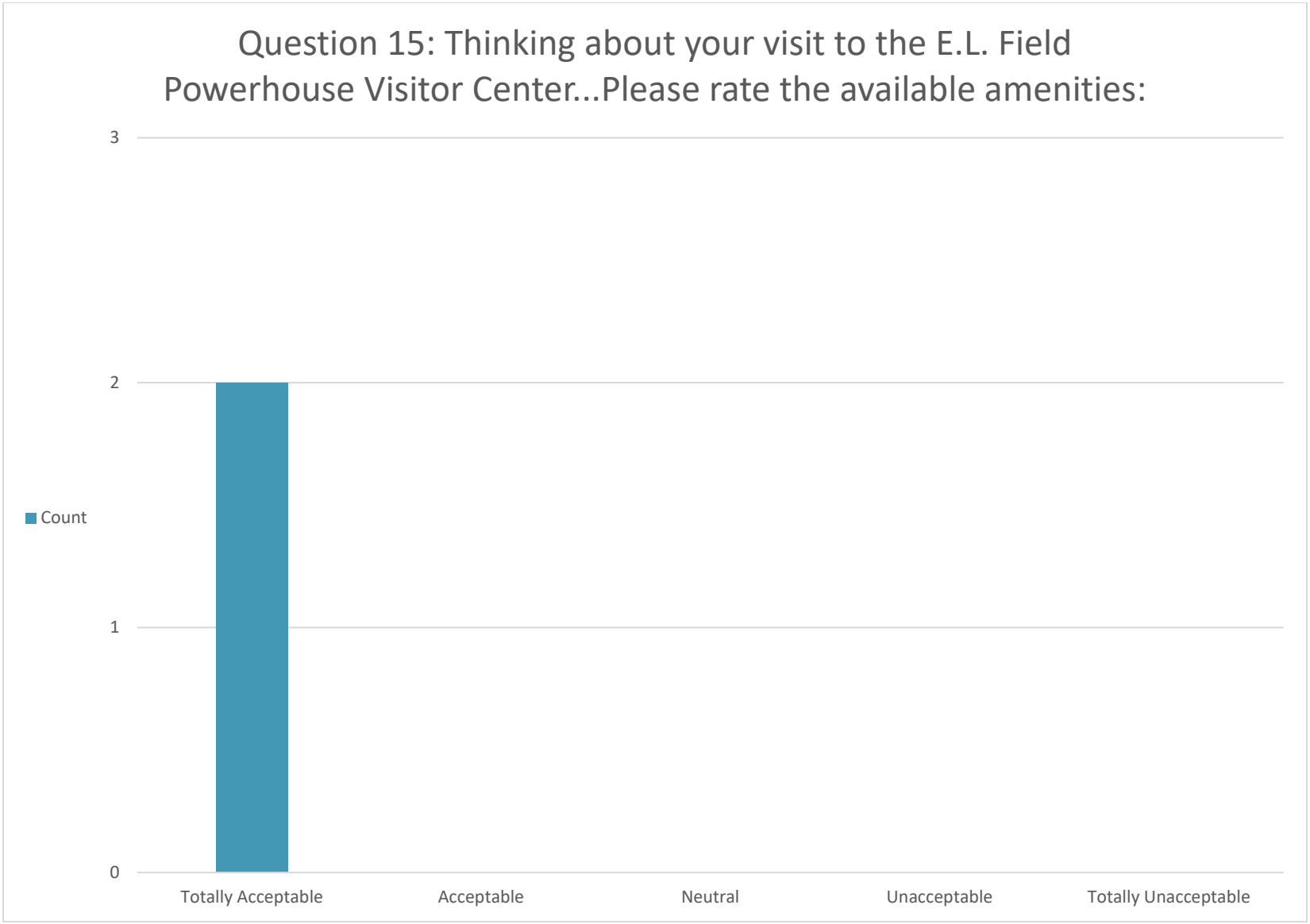
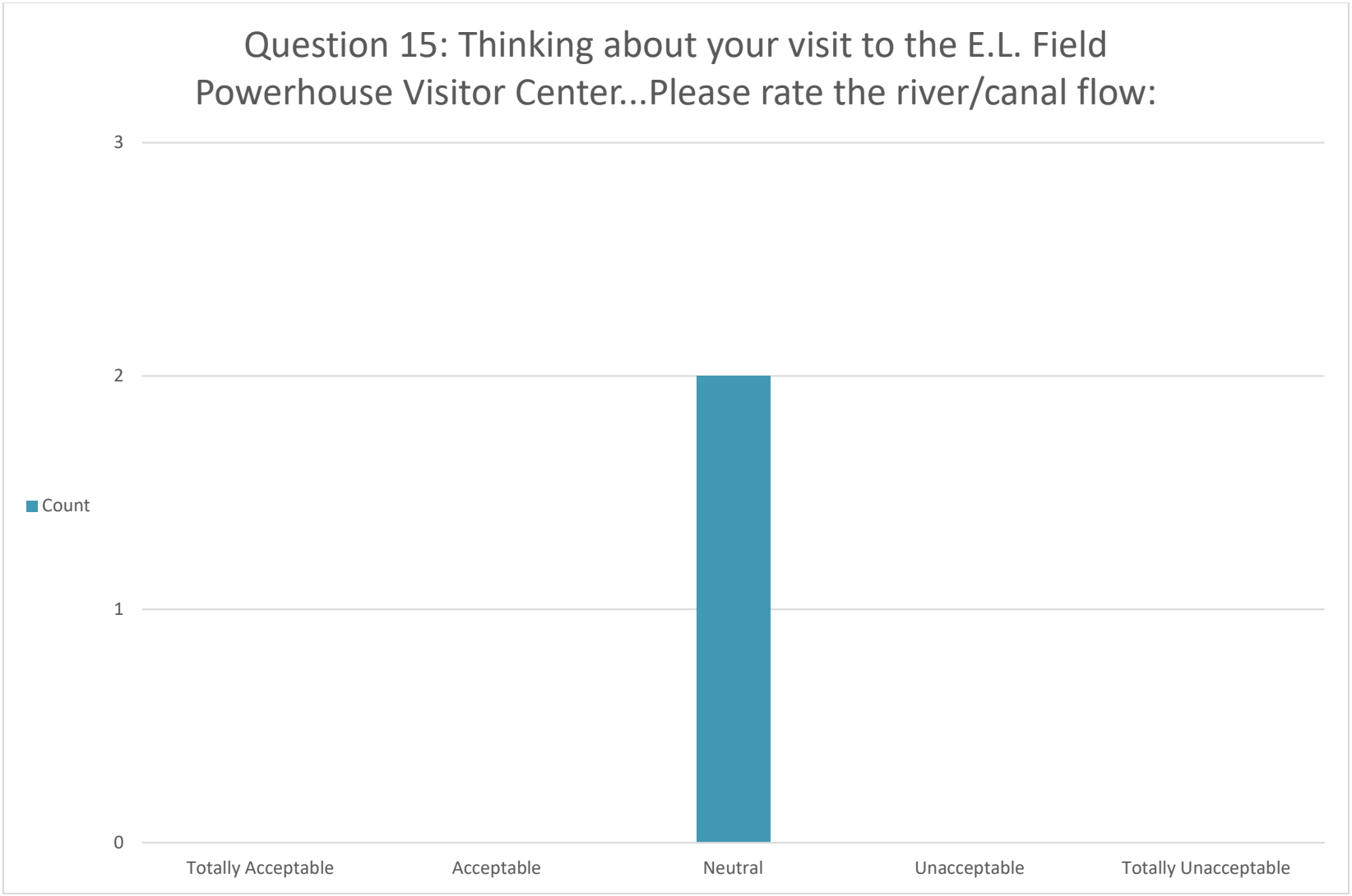


*Percentages not shown for respondent counts under ten.



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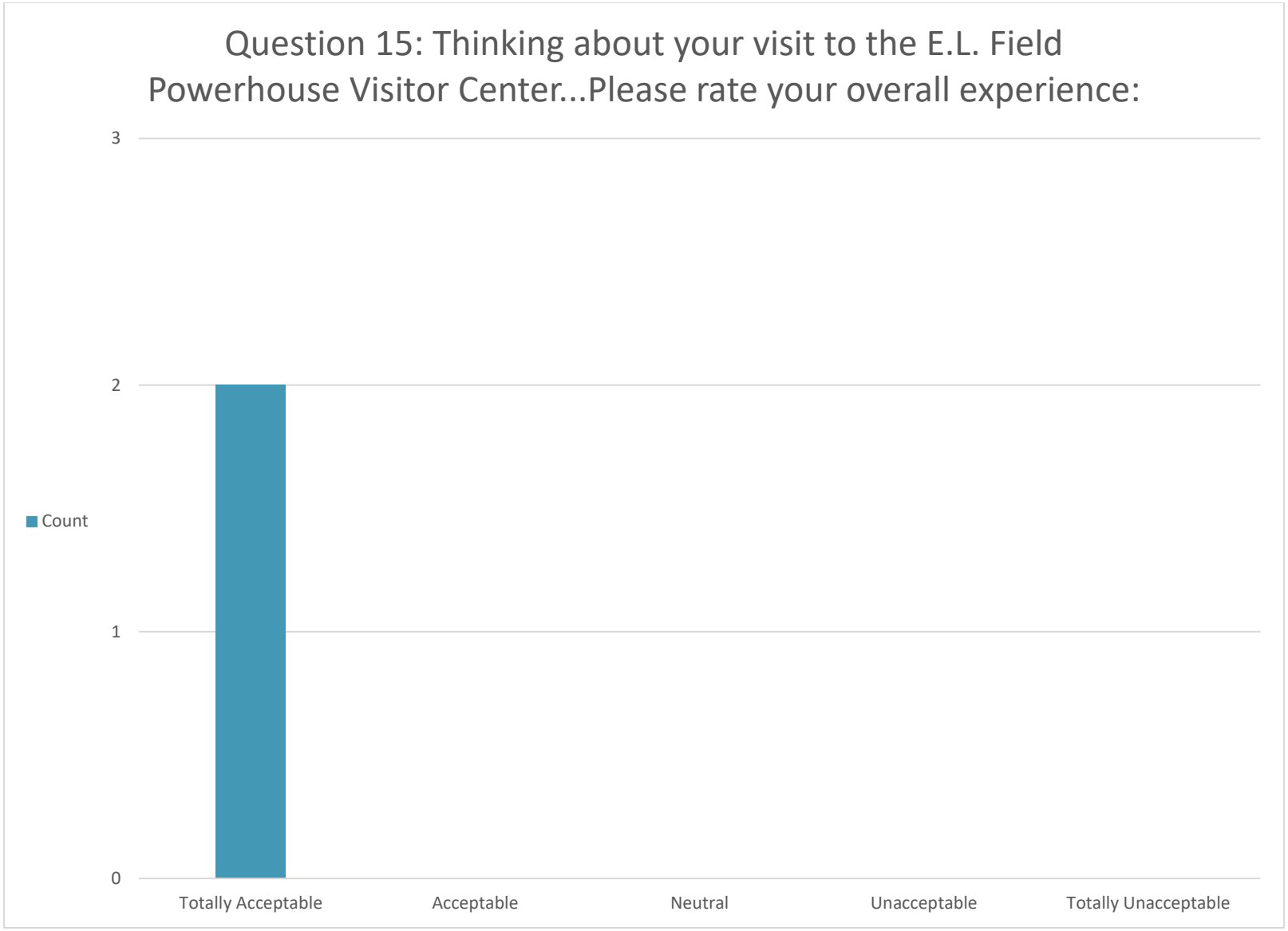
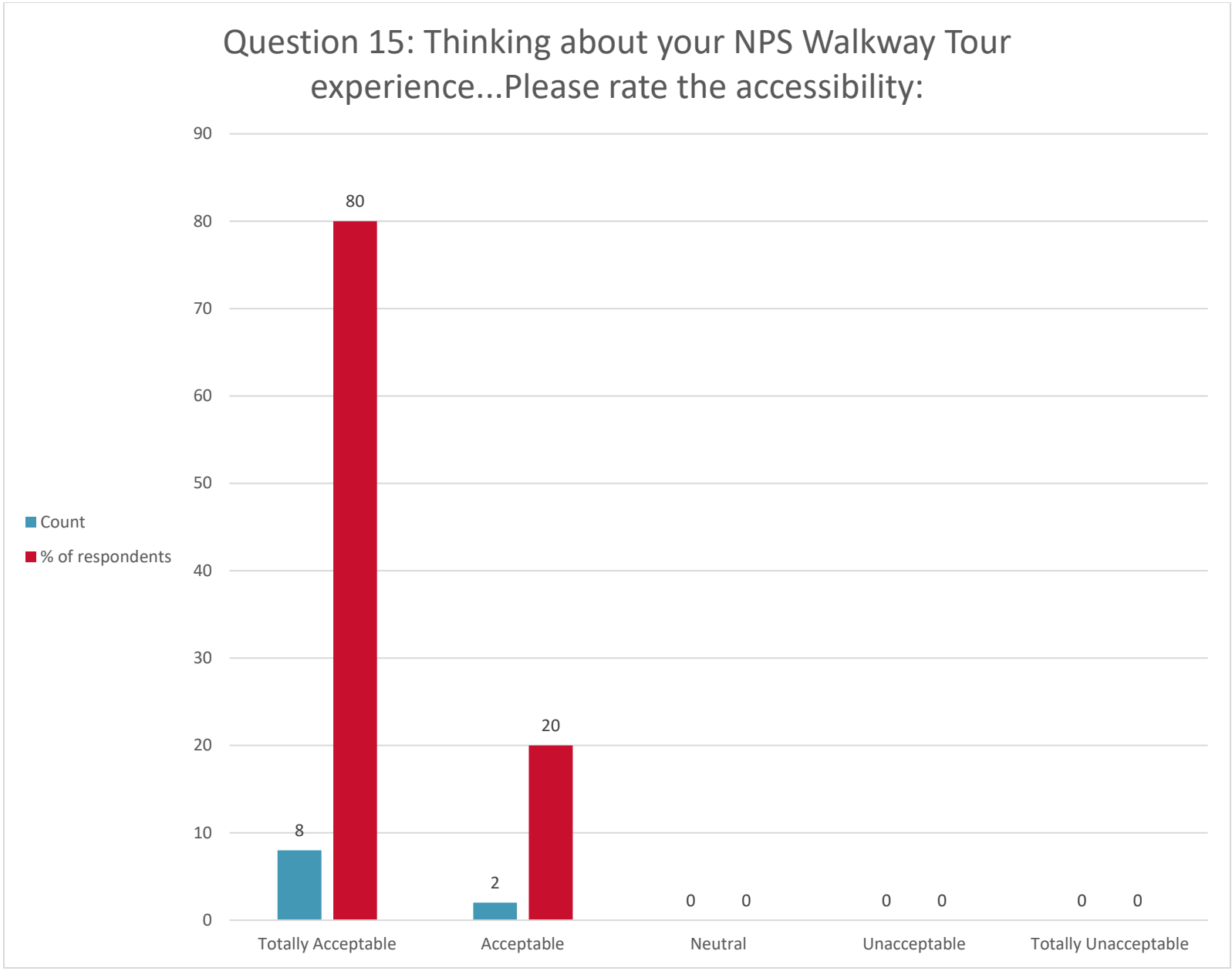
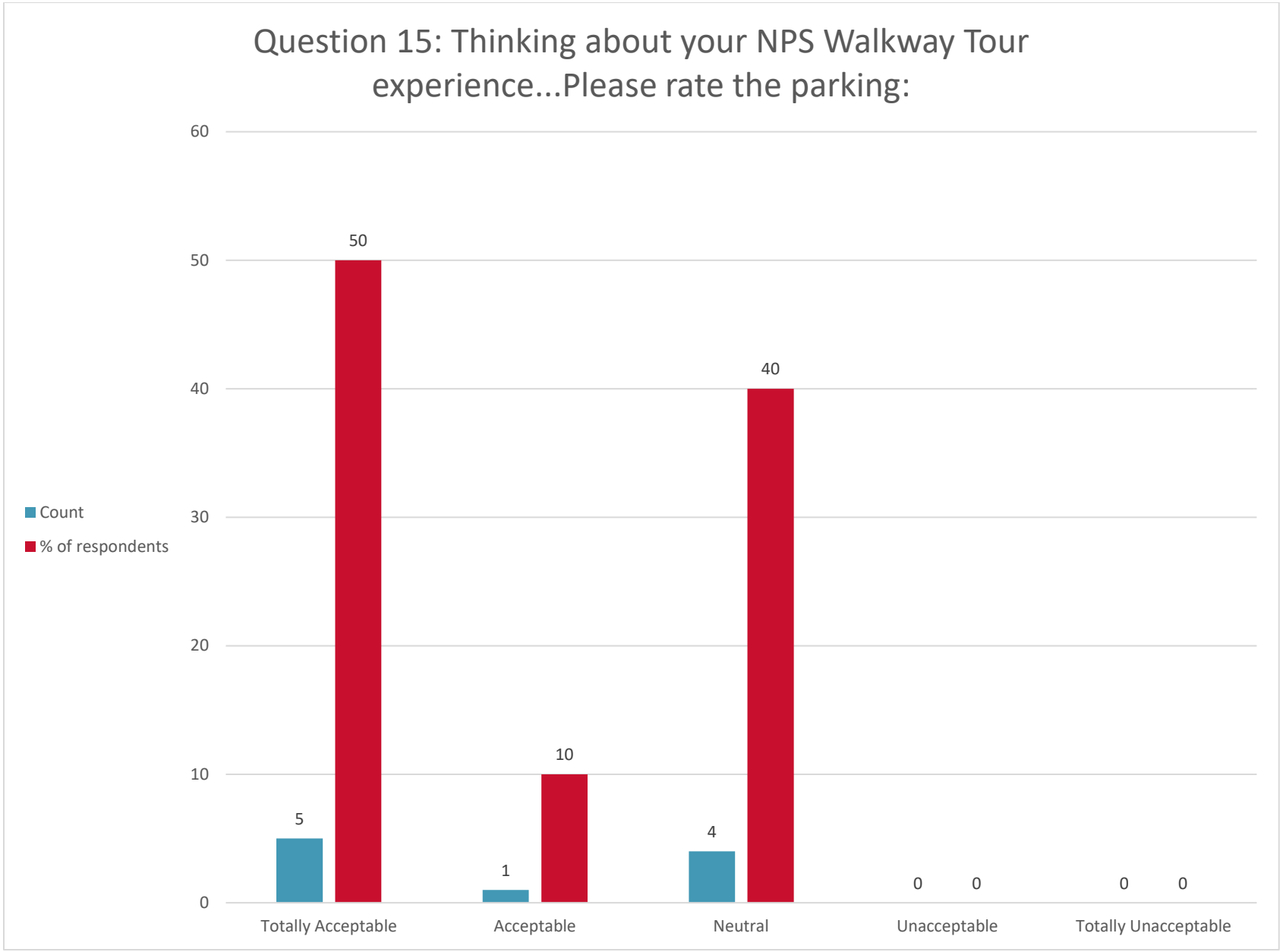
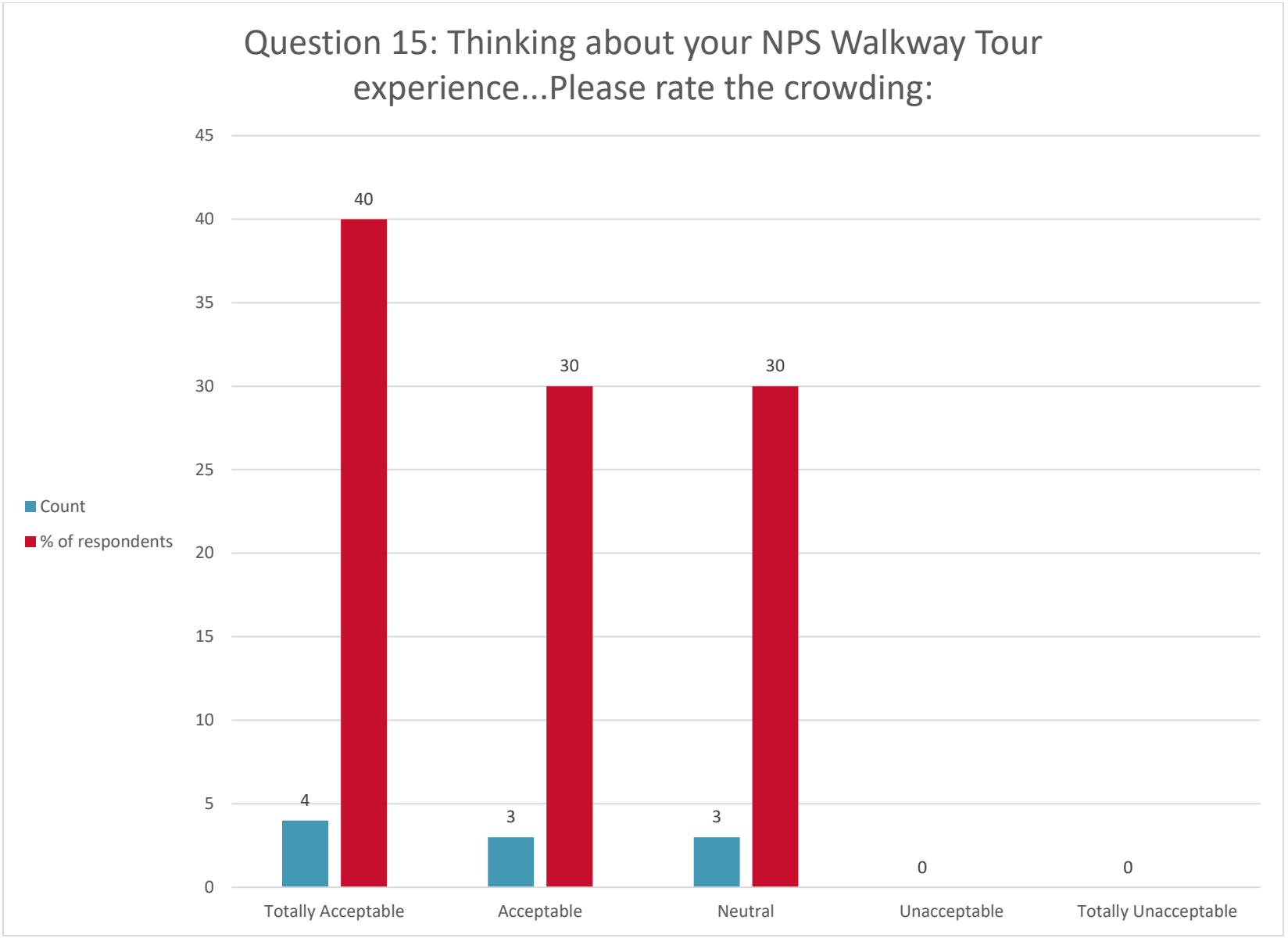
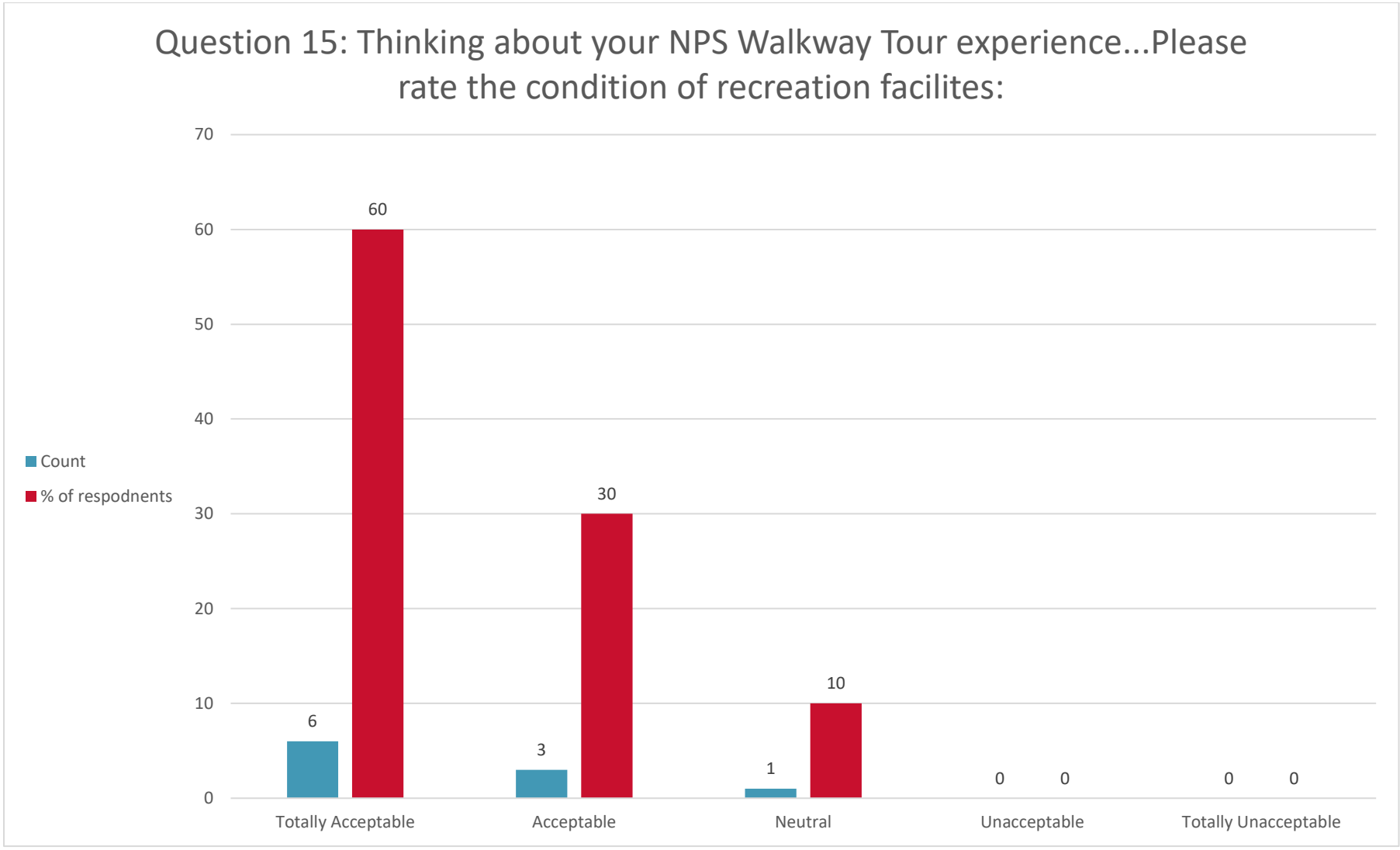


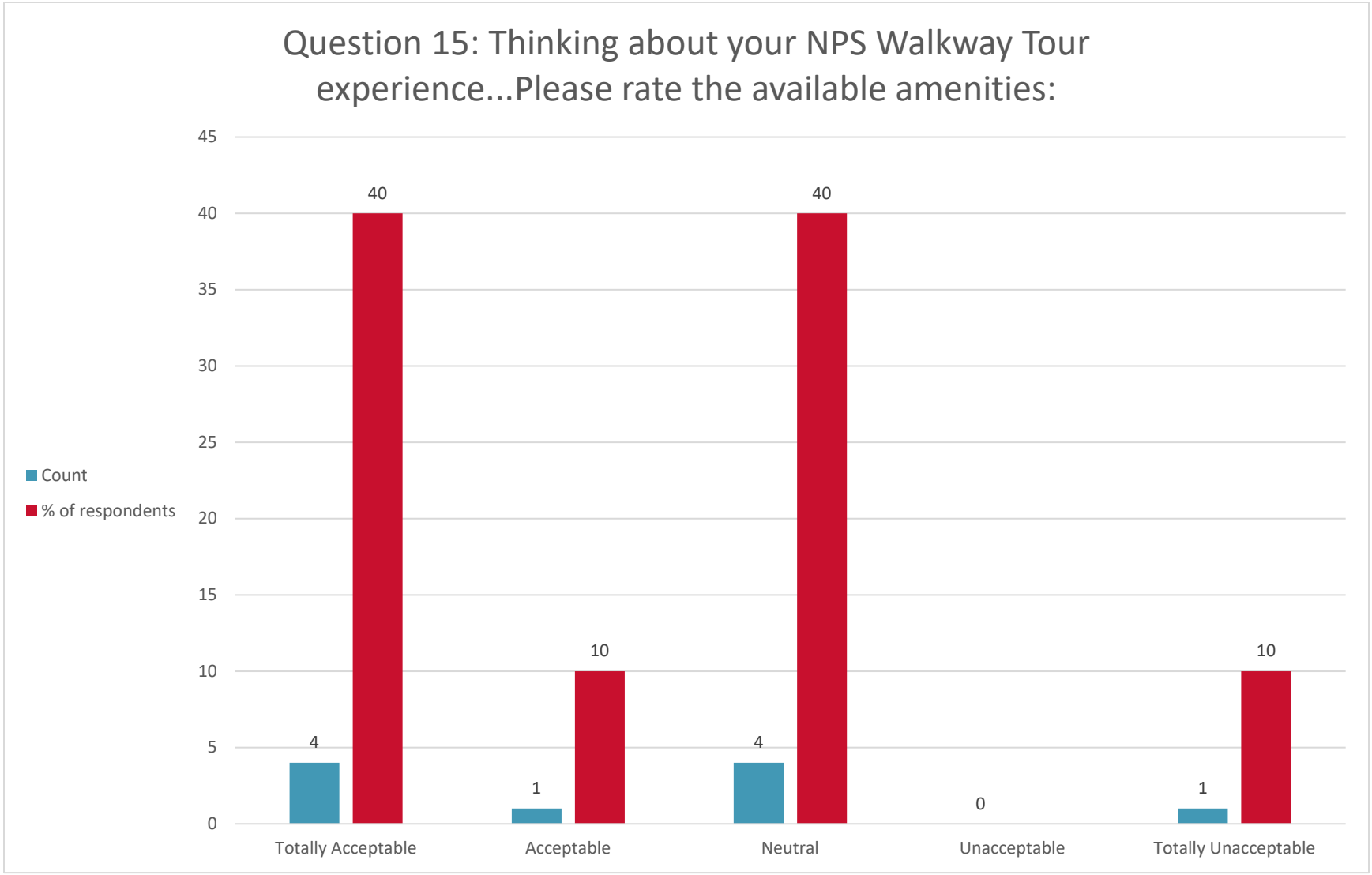
*Percentages not shown for respondent counts under ten.

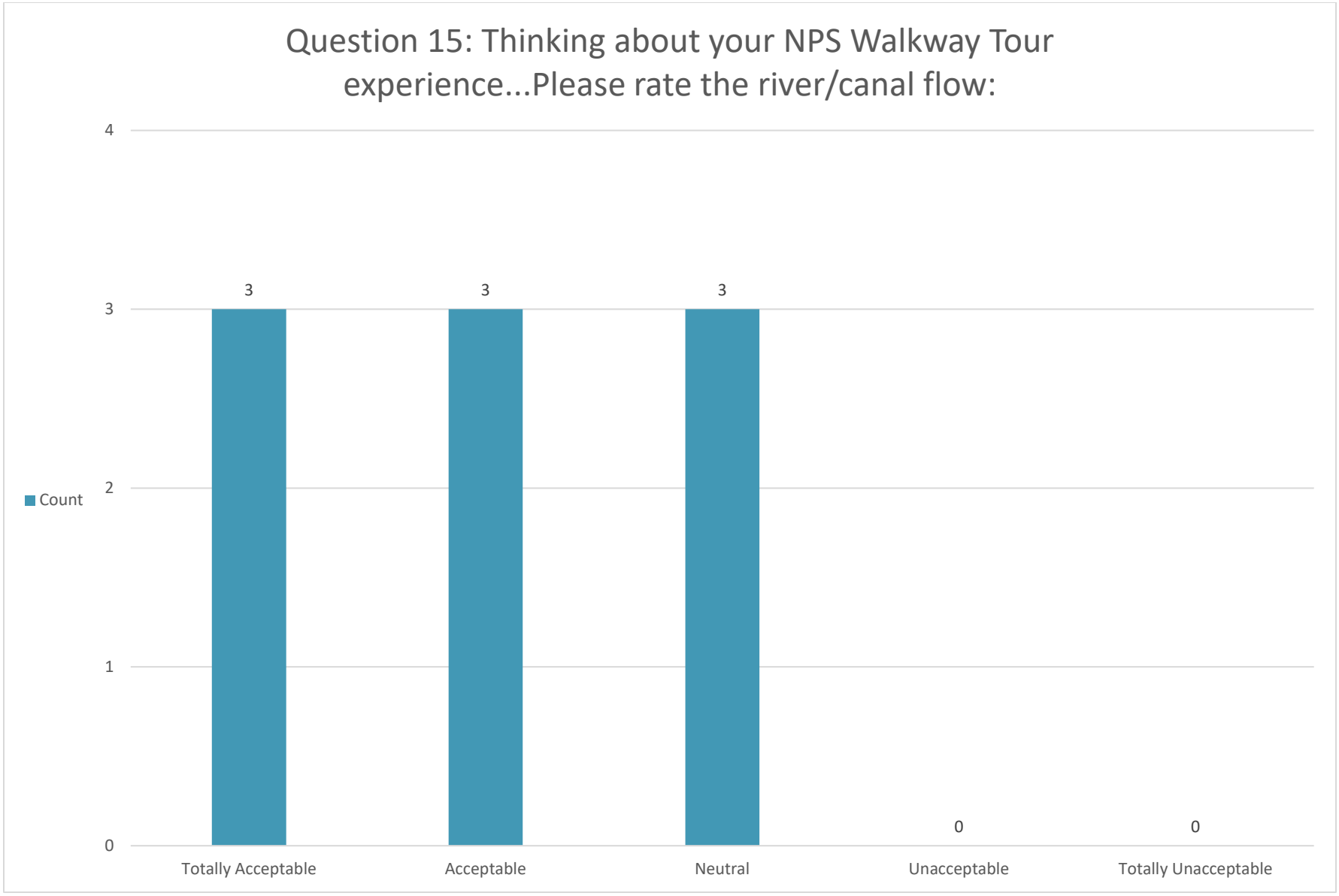

Question 15: Thinking about your NPS Walkway Tour experience...Please rate the accessibility:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
80
20
8
2
0
0
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your NPS Walkway Tour experience...Please rate the parking:
60
50
40
30
20
10
0
Count
% of respondents
5
50
1
10
4
40
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

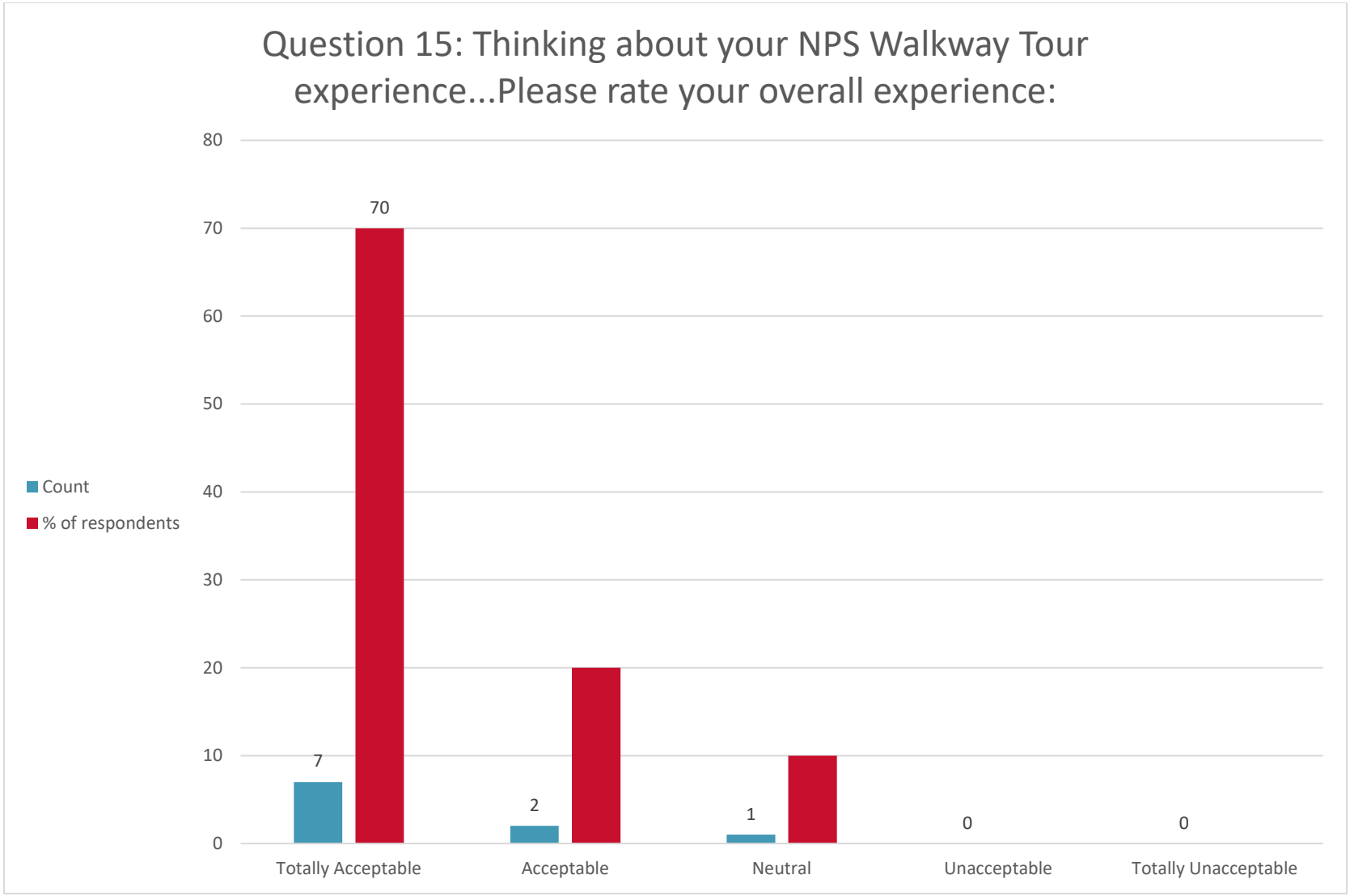

Question 15: Thinking about your NPS Walkway Tour experience...Please rate the crowding:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
40
30
30
4
3
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

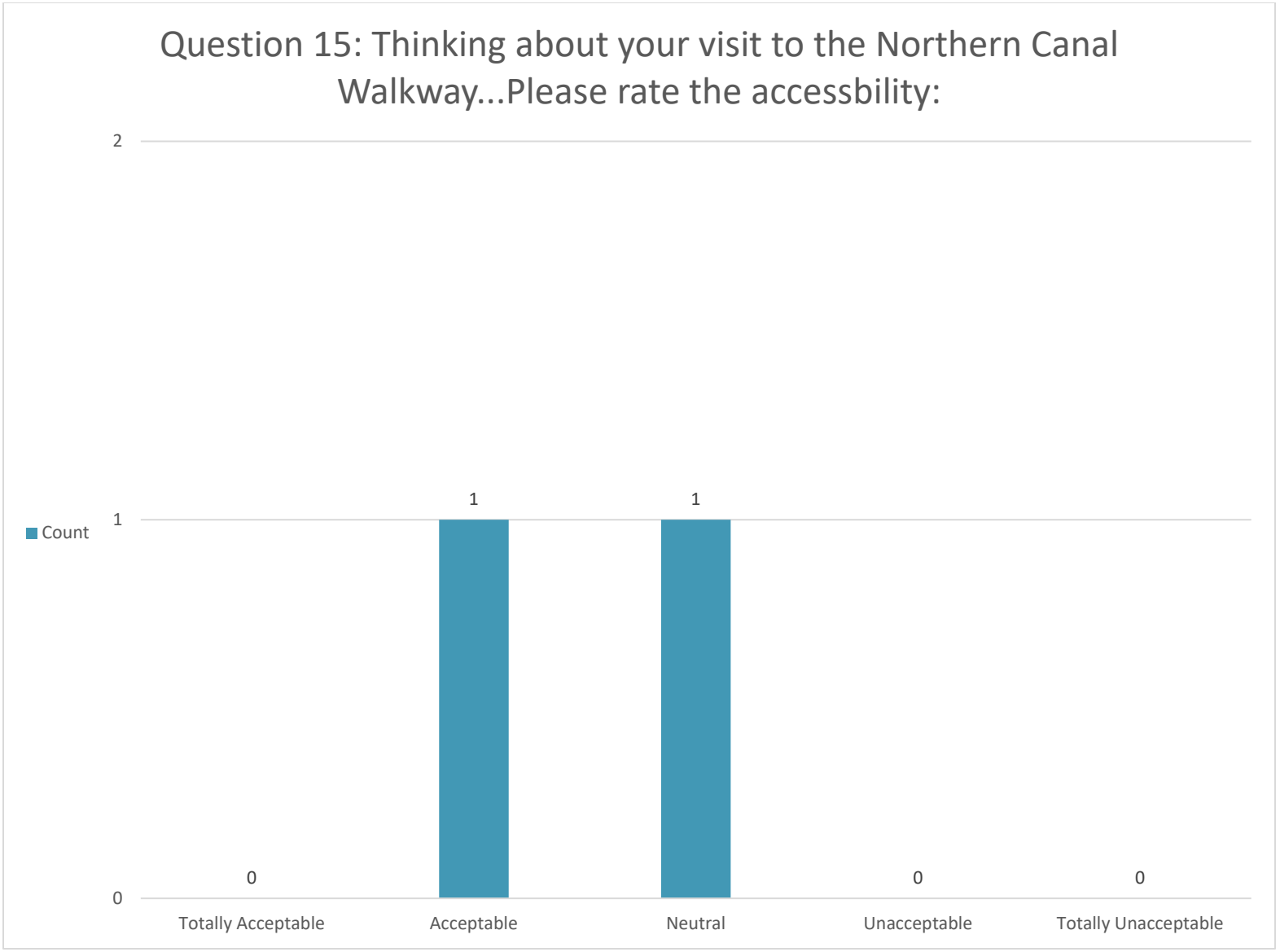

Question 15: Thinking about your NPS Walkway Tour experience...Please rate the condition of recreation facilites:
70
60
50
40
30
20
10
0
Count
% of respodnents
60
30
6
3
10
1
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your NPS Walkway Tour experience...Please rate the available amenities:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
40
40
10
10
4
1
4
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

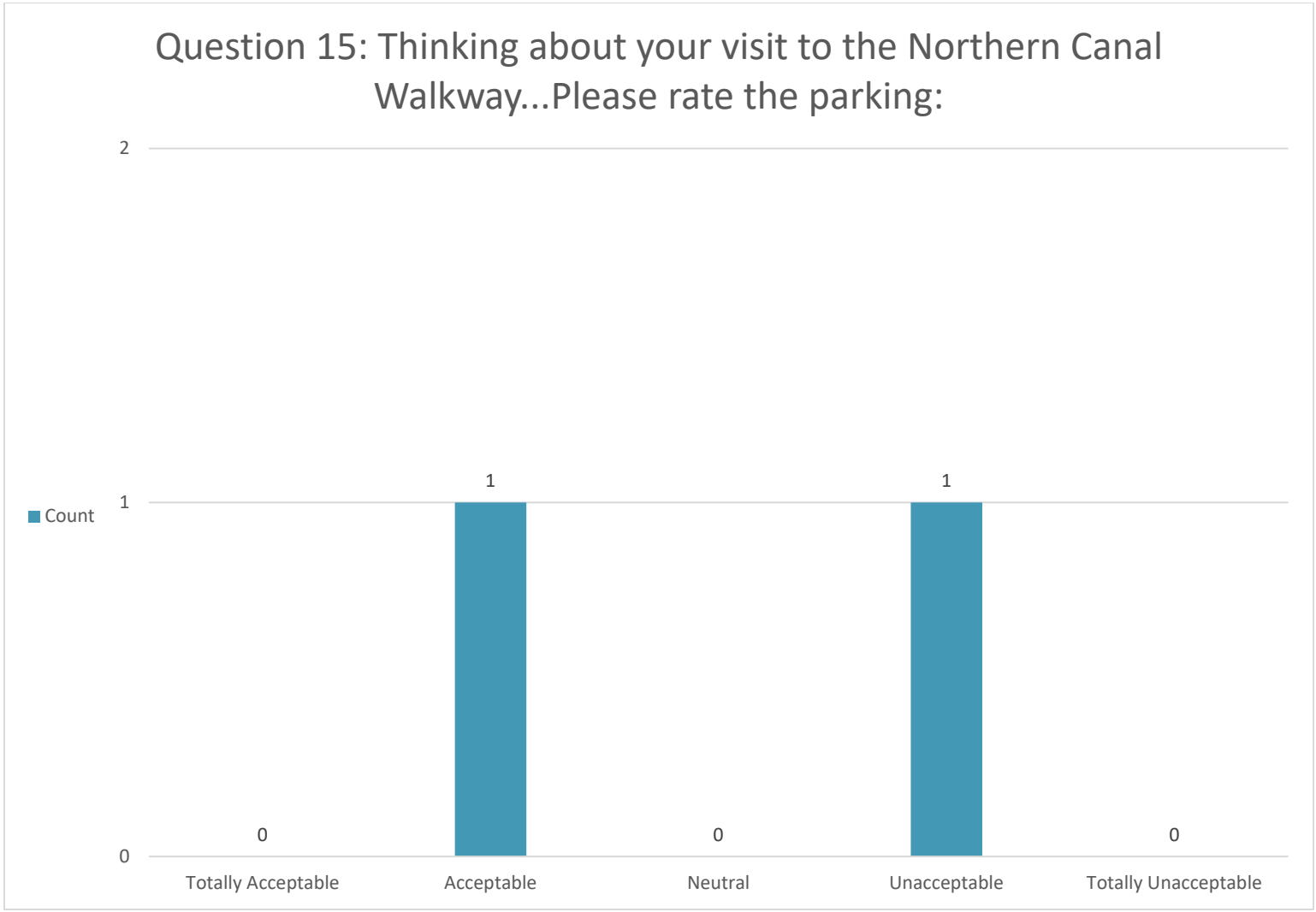


*Percentages not shown for respondent counts under ten.

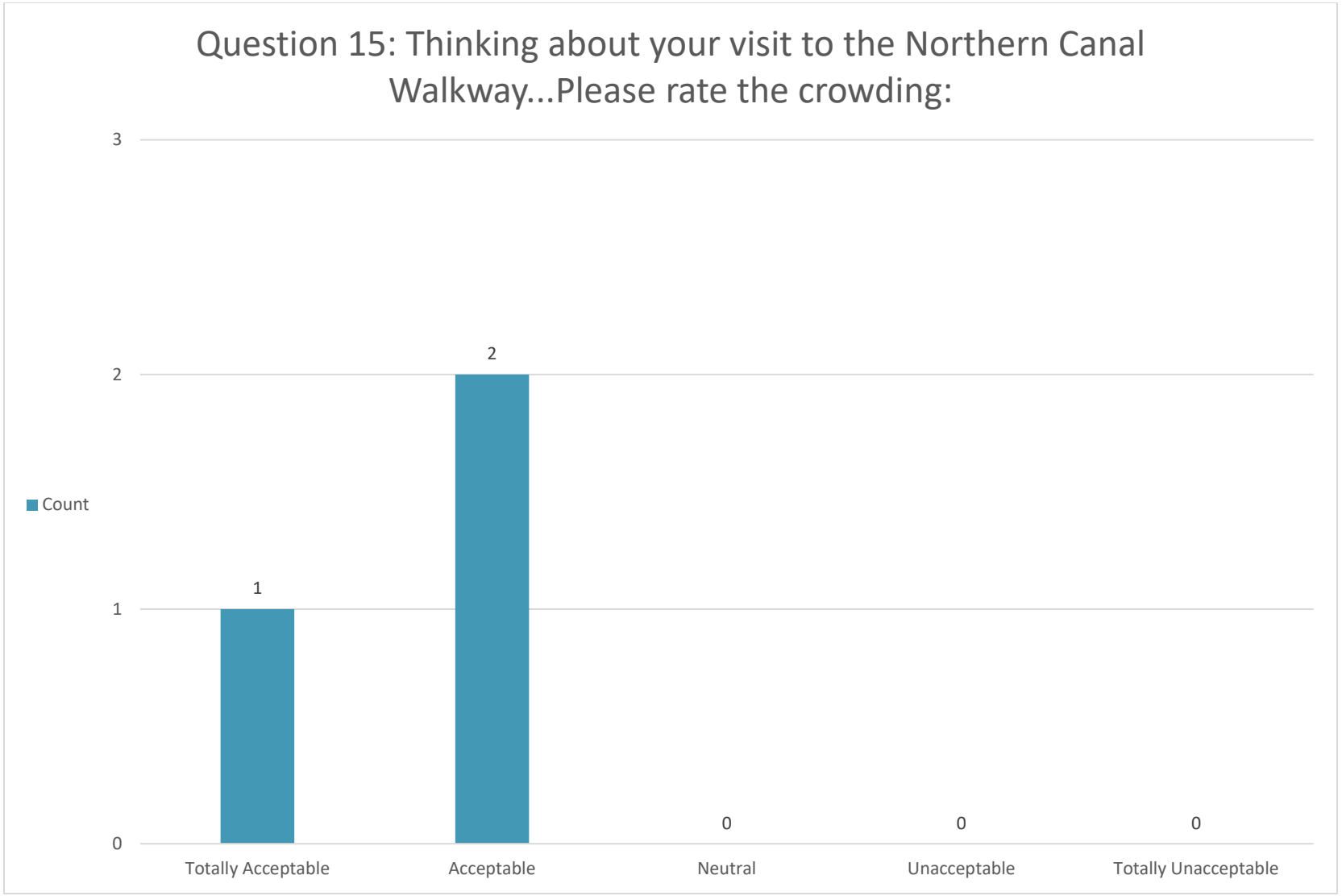

Question 15: Thinking about your NPS Walkway Tour experience...Please rate your overall experience:
80
70
60
50
40
30
20
10
0
Count
% of respondents
70
7
2
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable



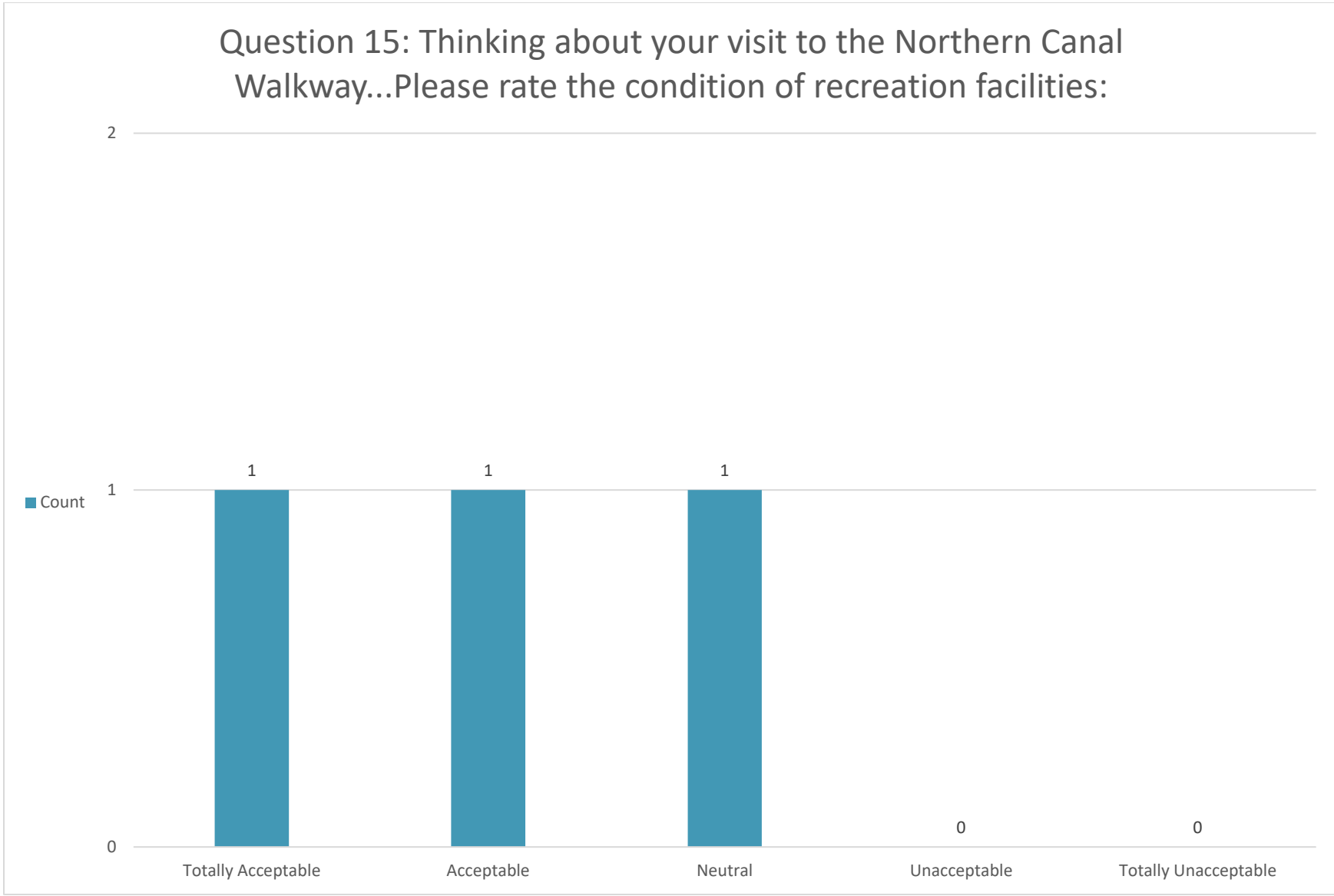
*Percentages not shown for respondent counts under ten.



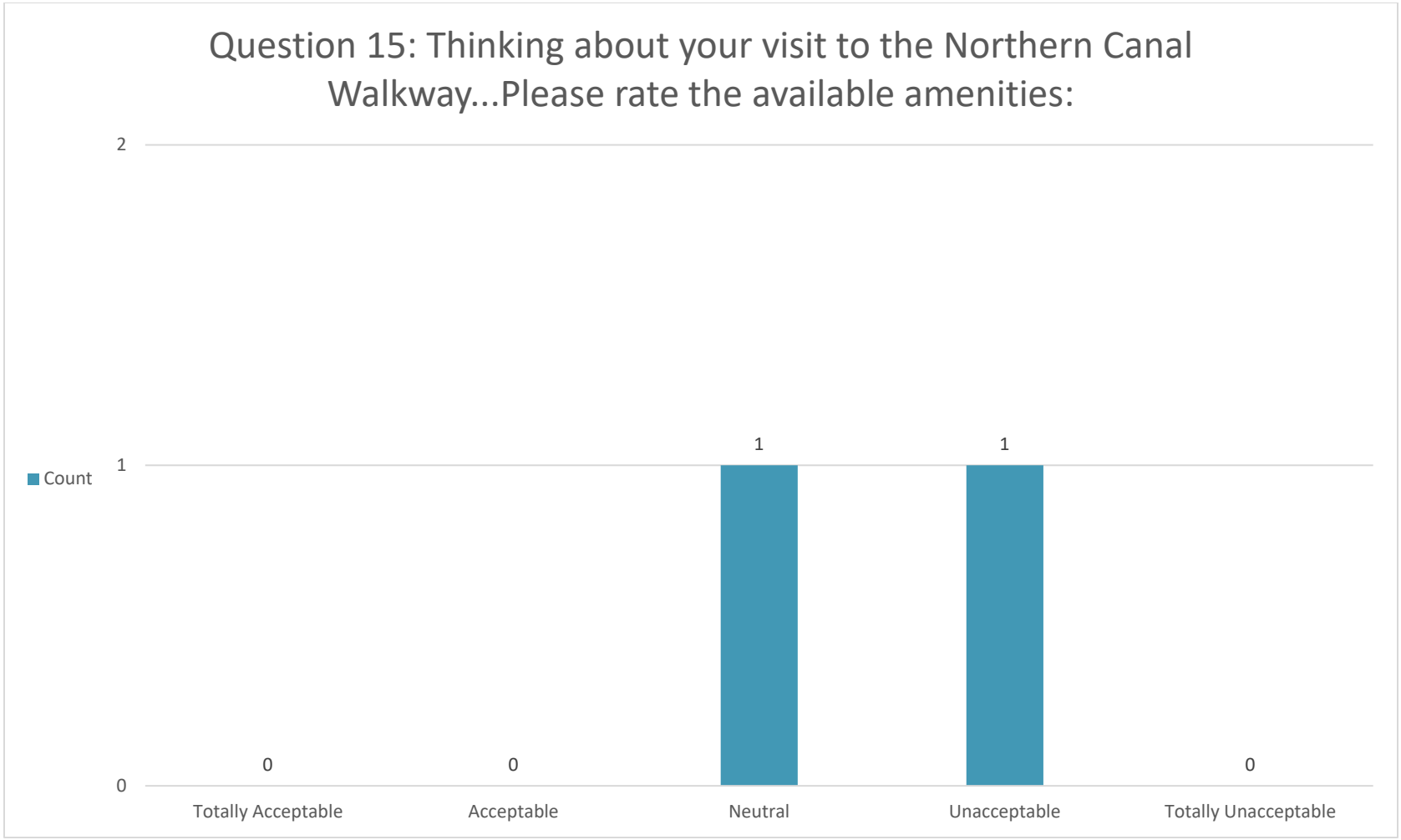
*Percentages not shown for respondent counts under ten.



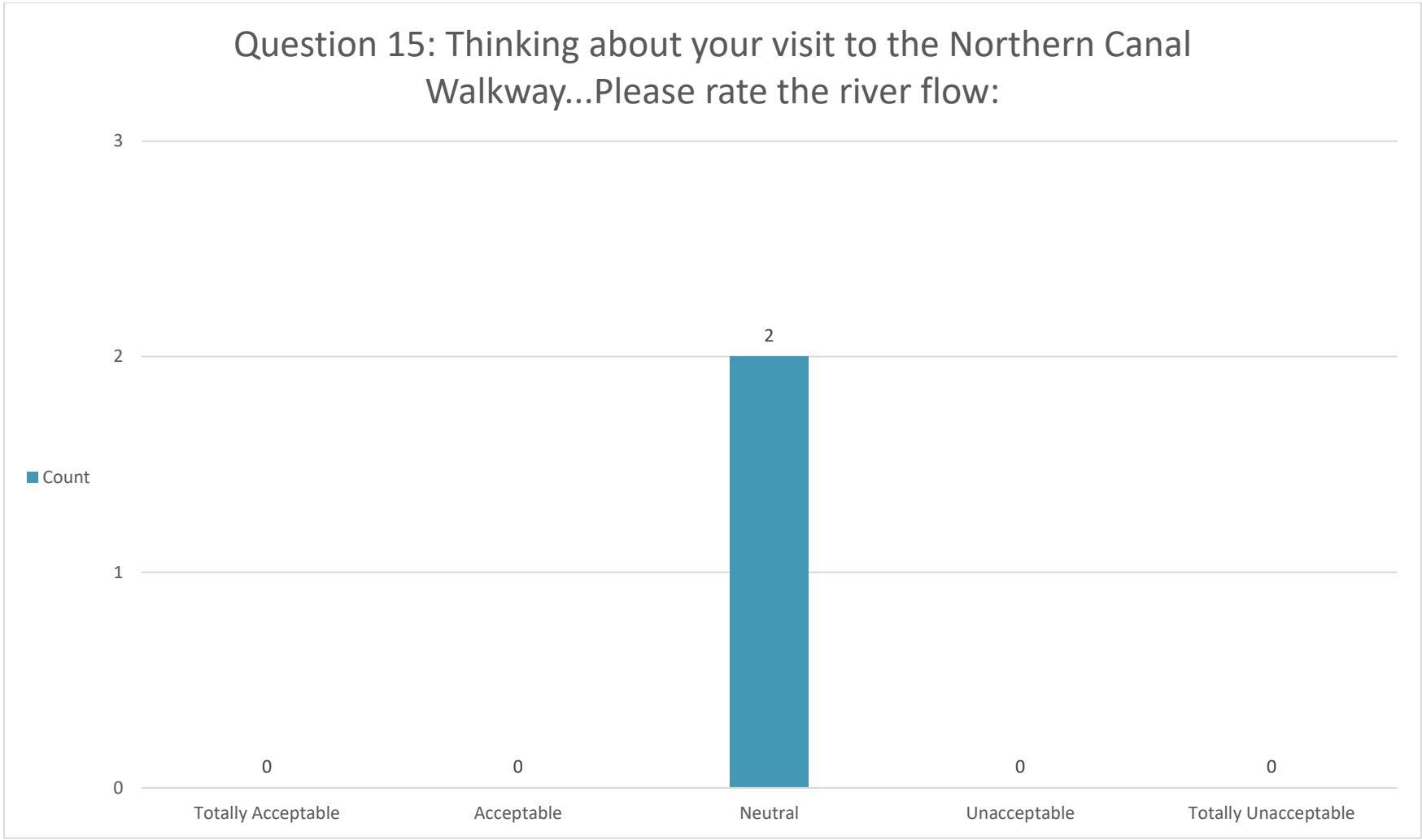
*Percentages not shown for respondent counts under ten.



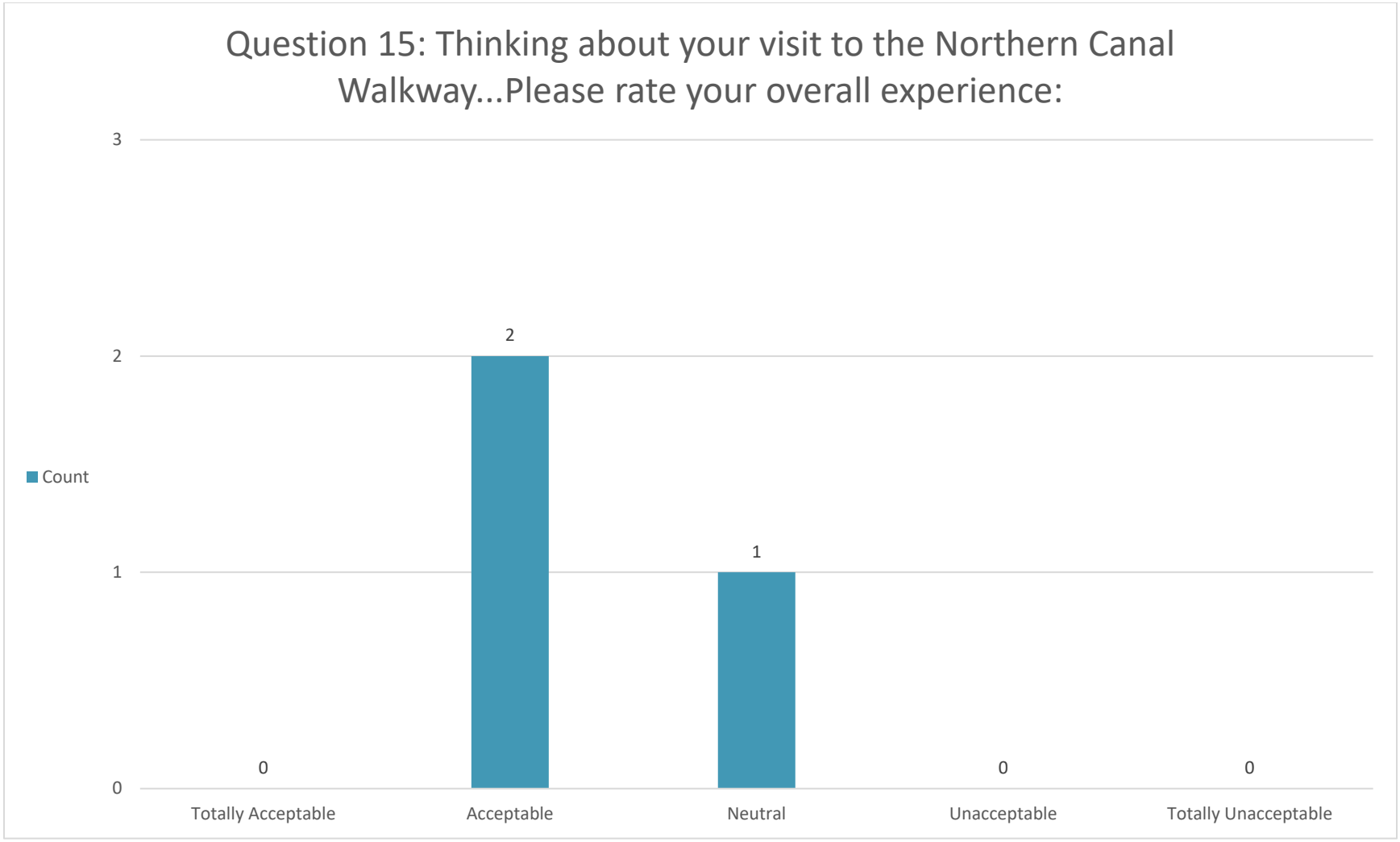
*Percentages not shown for respondent counts under ten.



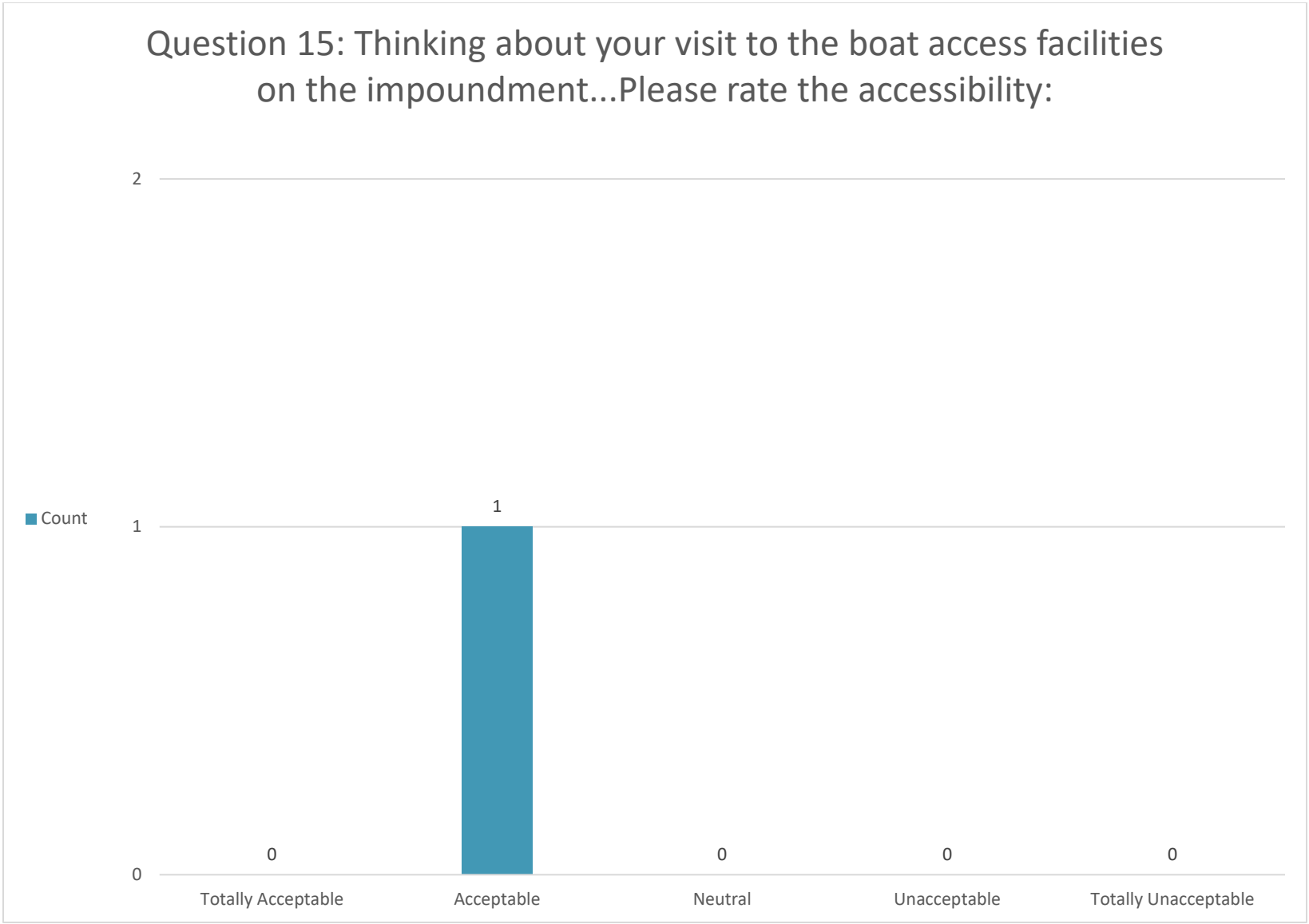
*Percentages not shown for respondent counts under ten.



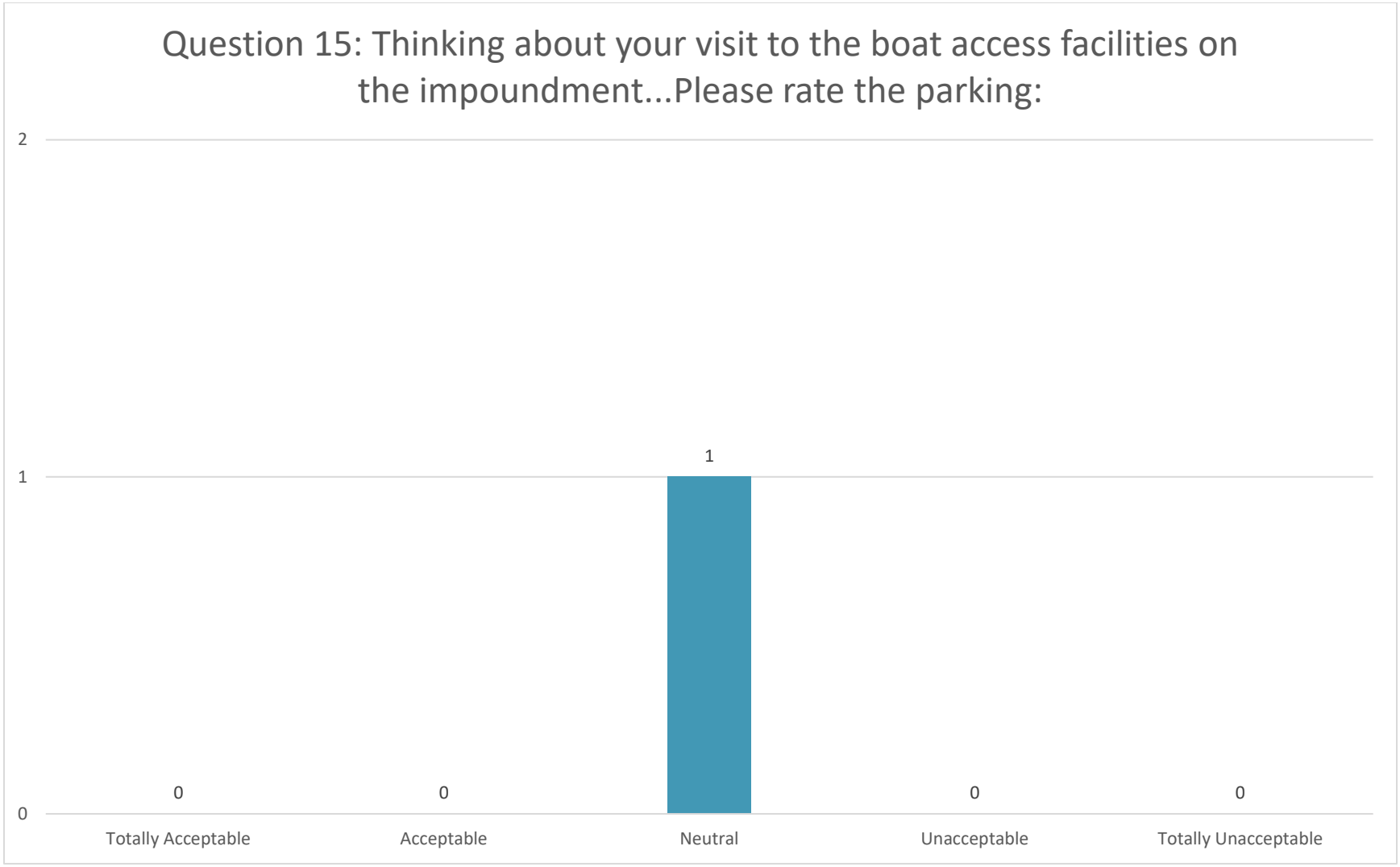
*Percentages not shown for respondent counts under ten.



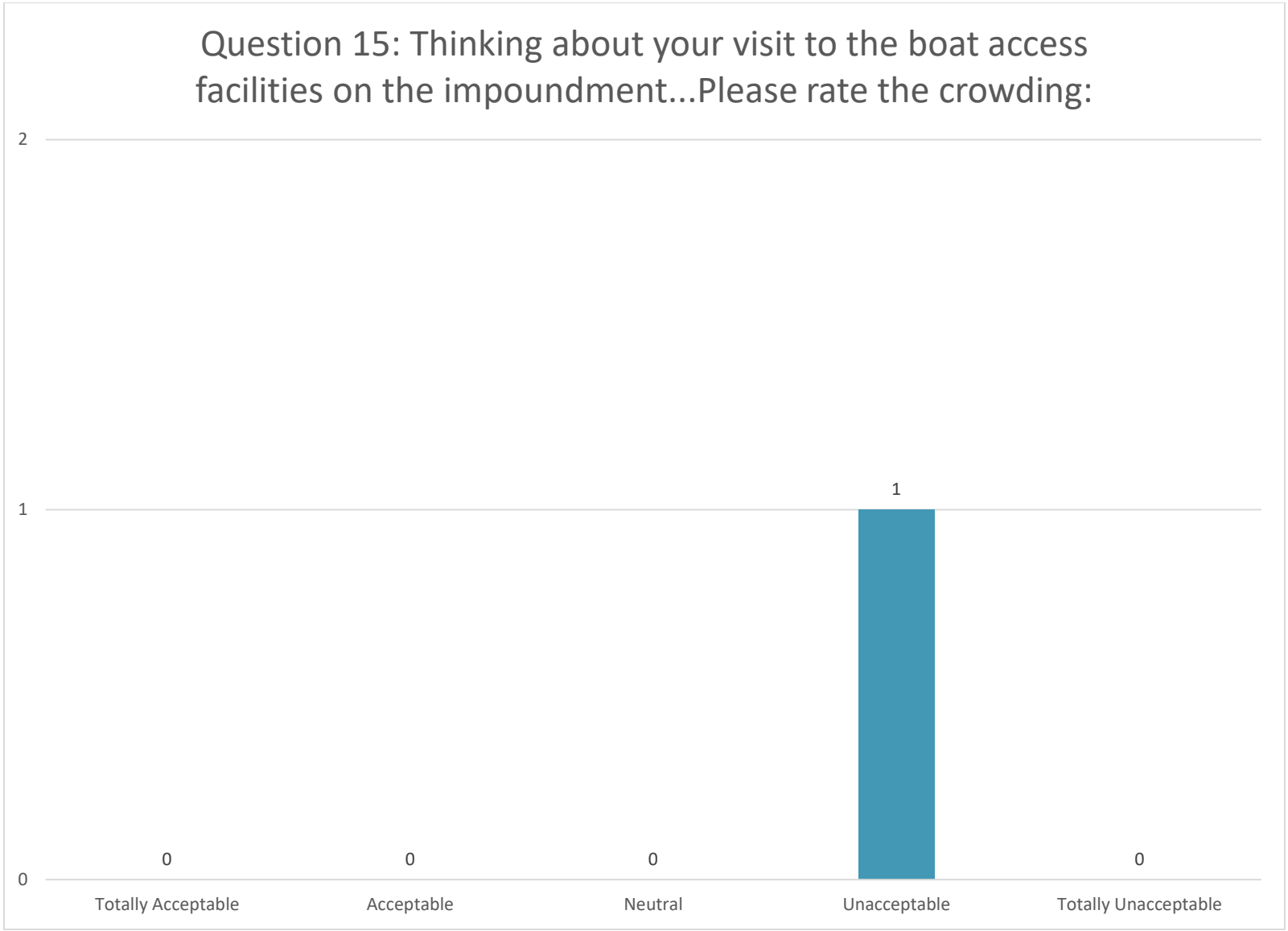
*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



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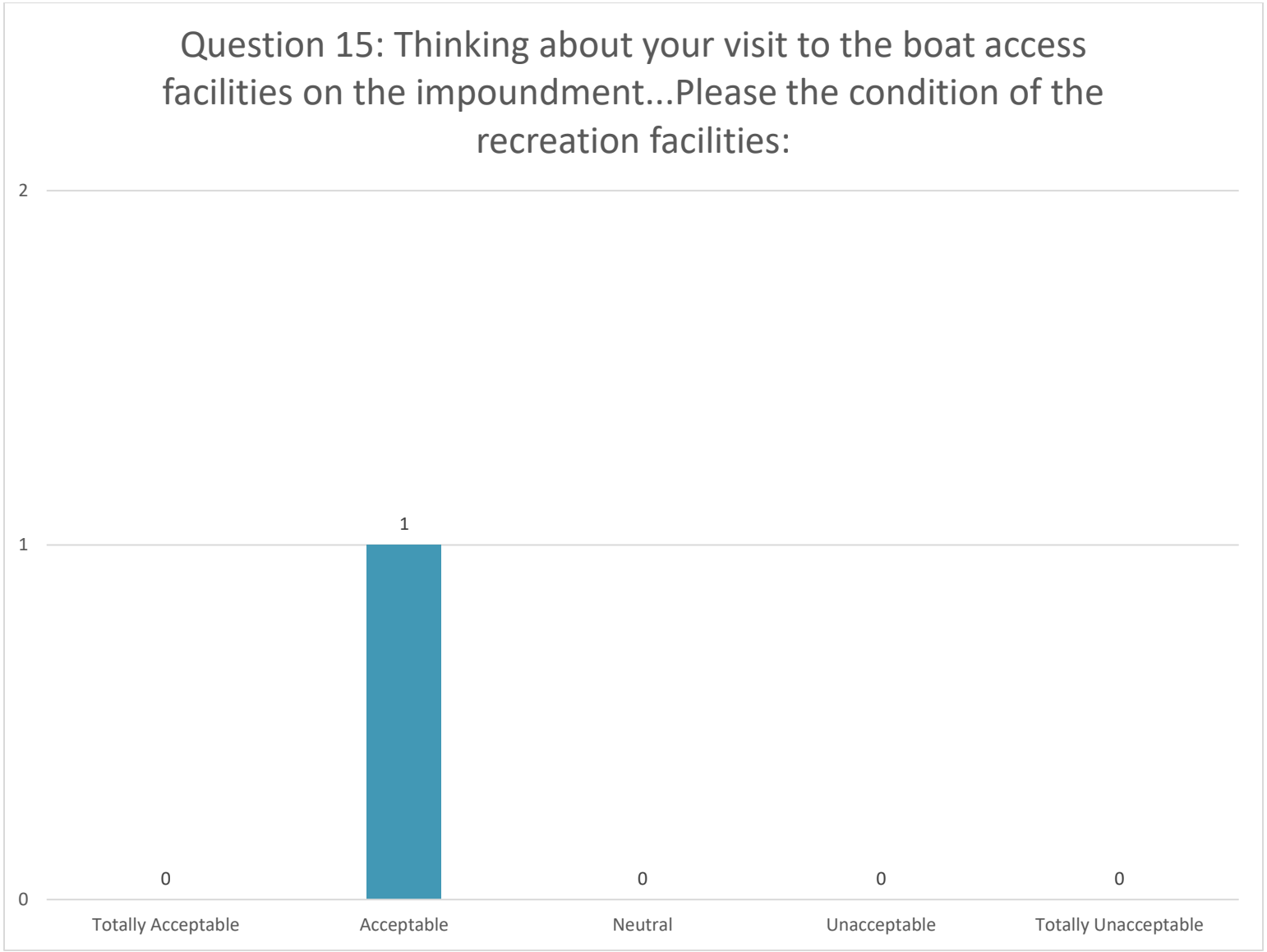
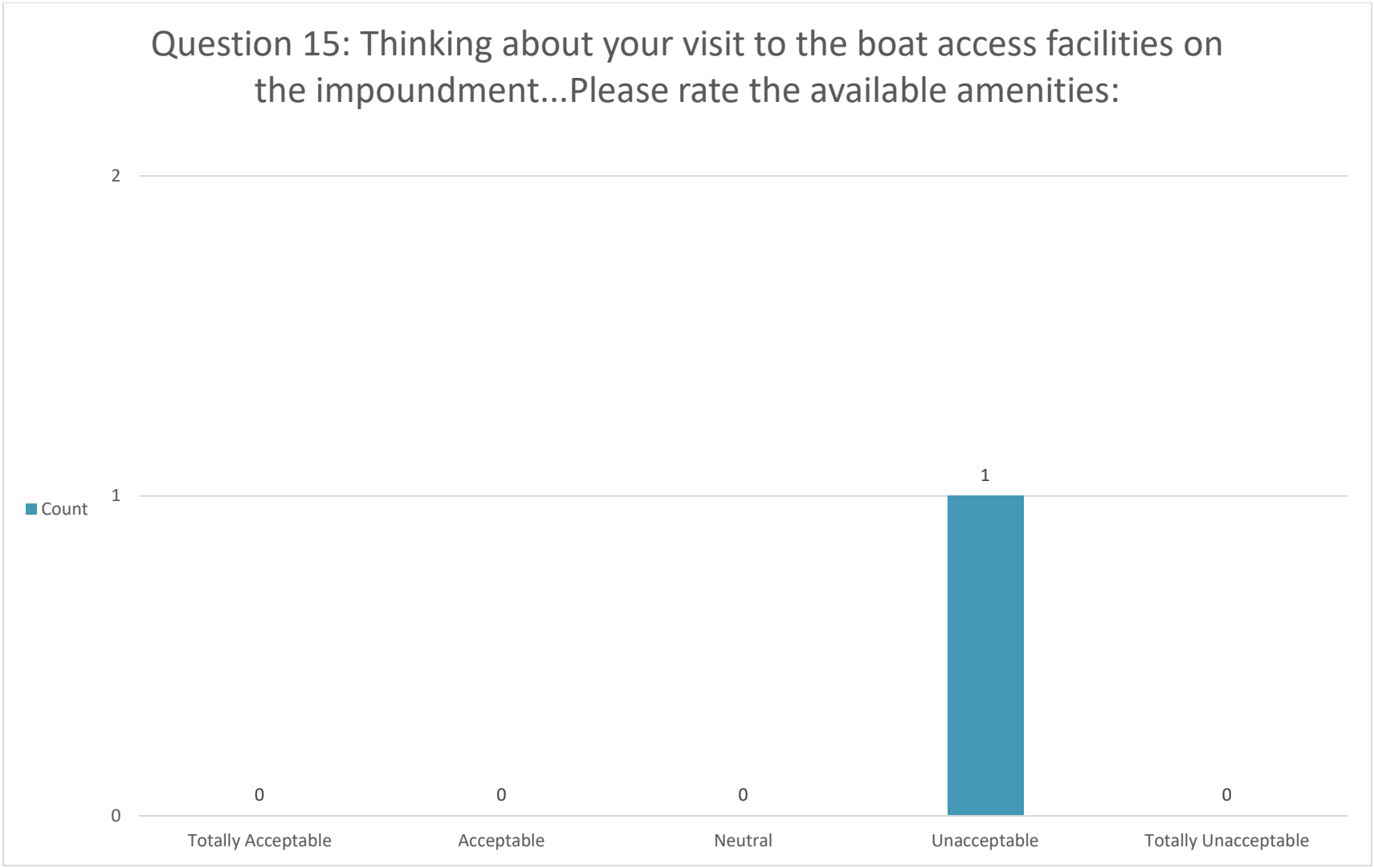
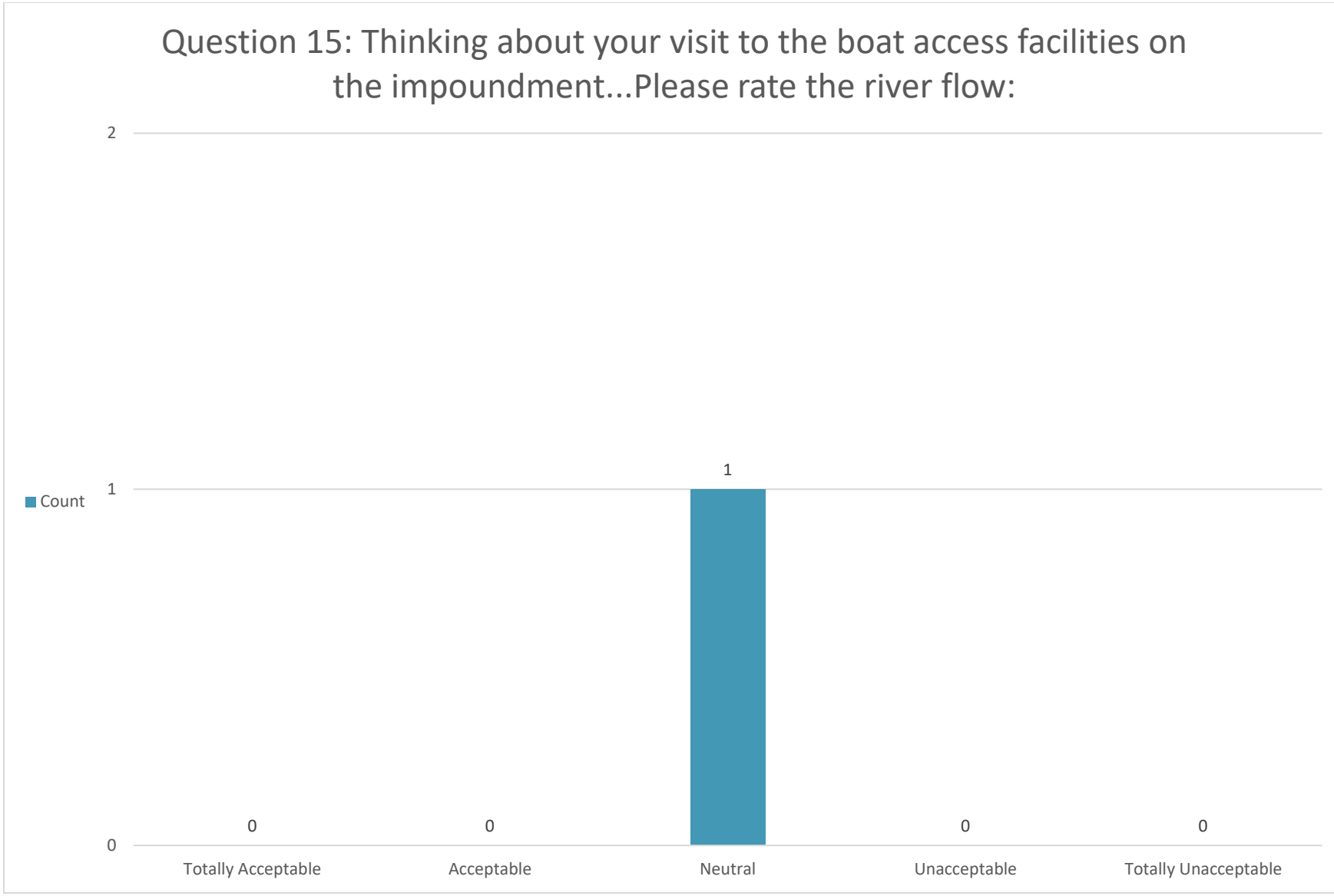


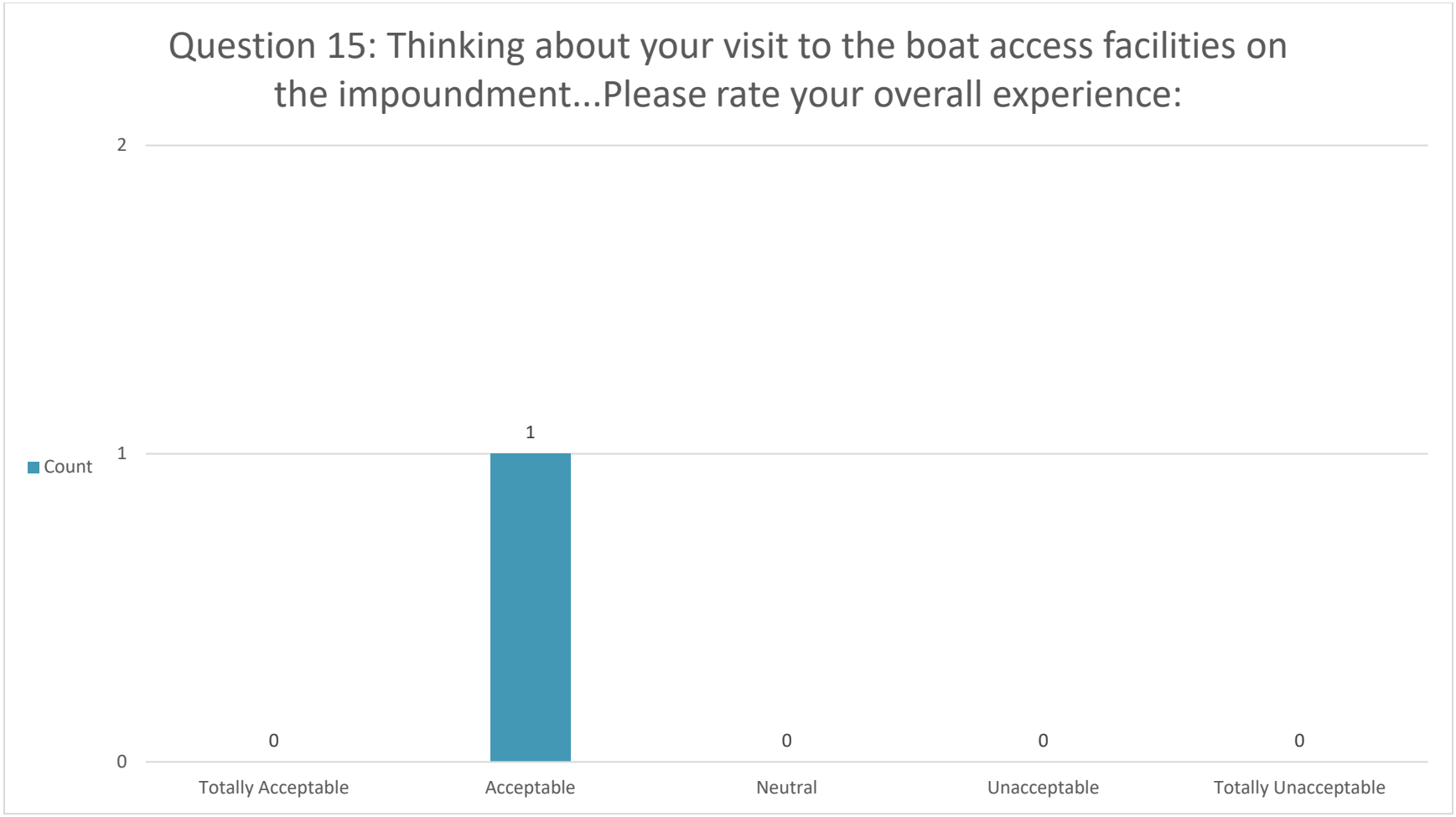
*Percentages not shown for respondent counts under ten.



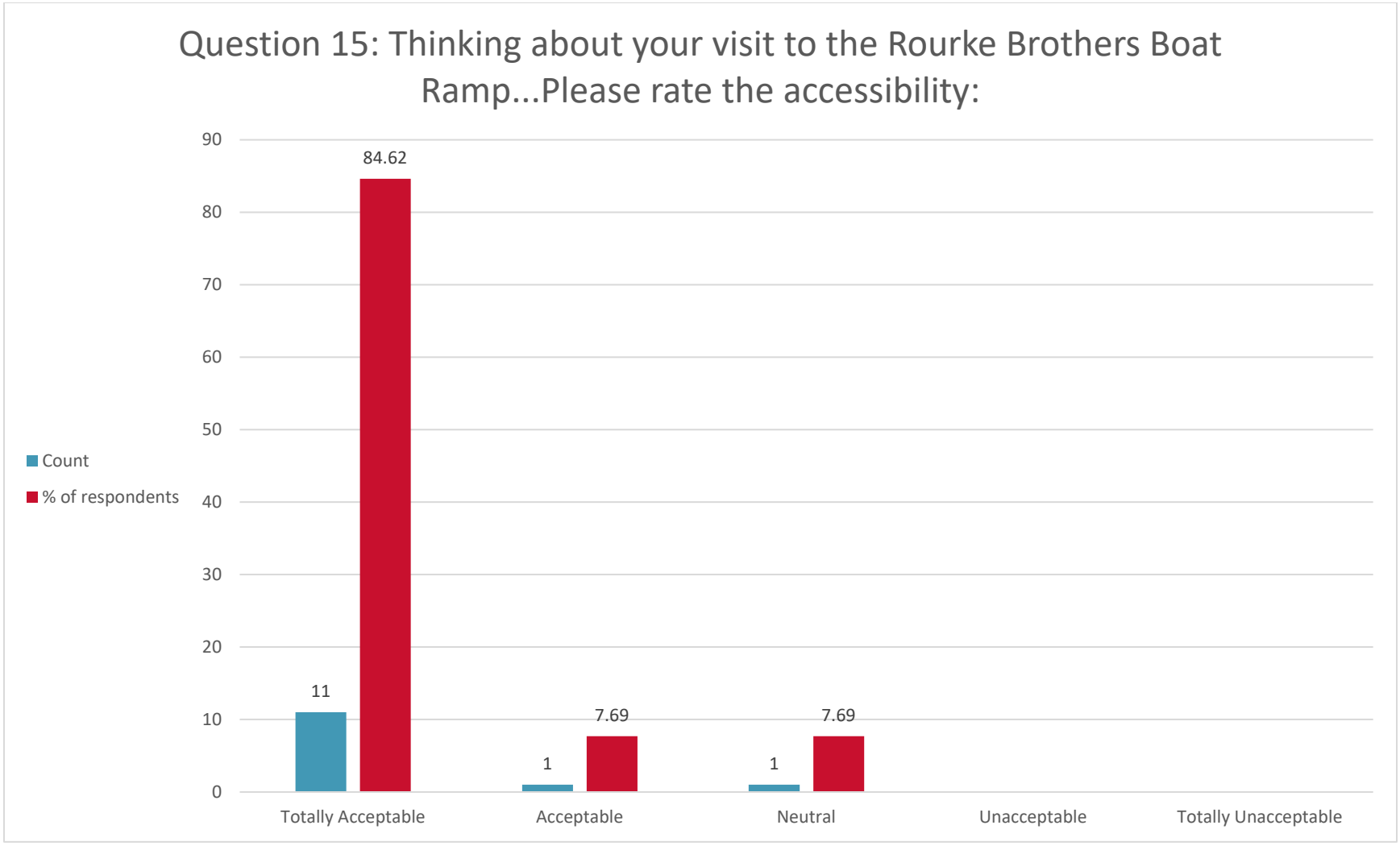
*Percentages not shown for respondent counts under ten.

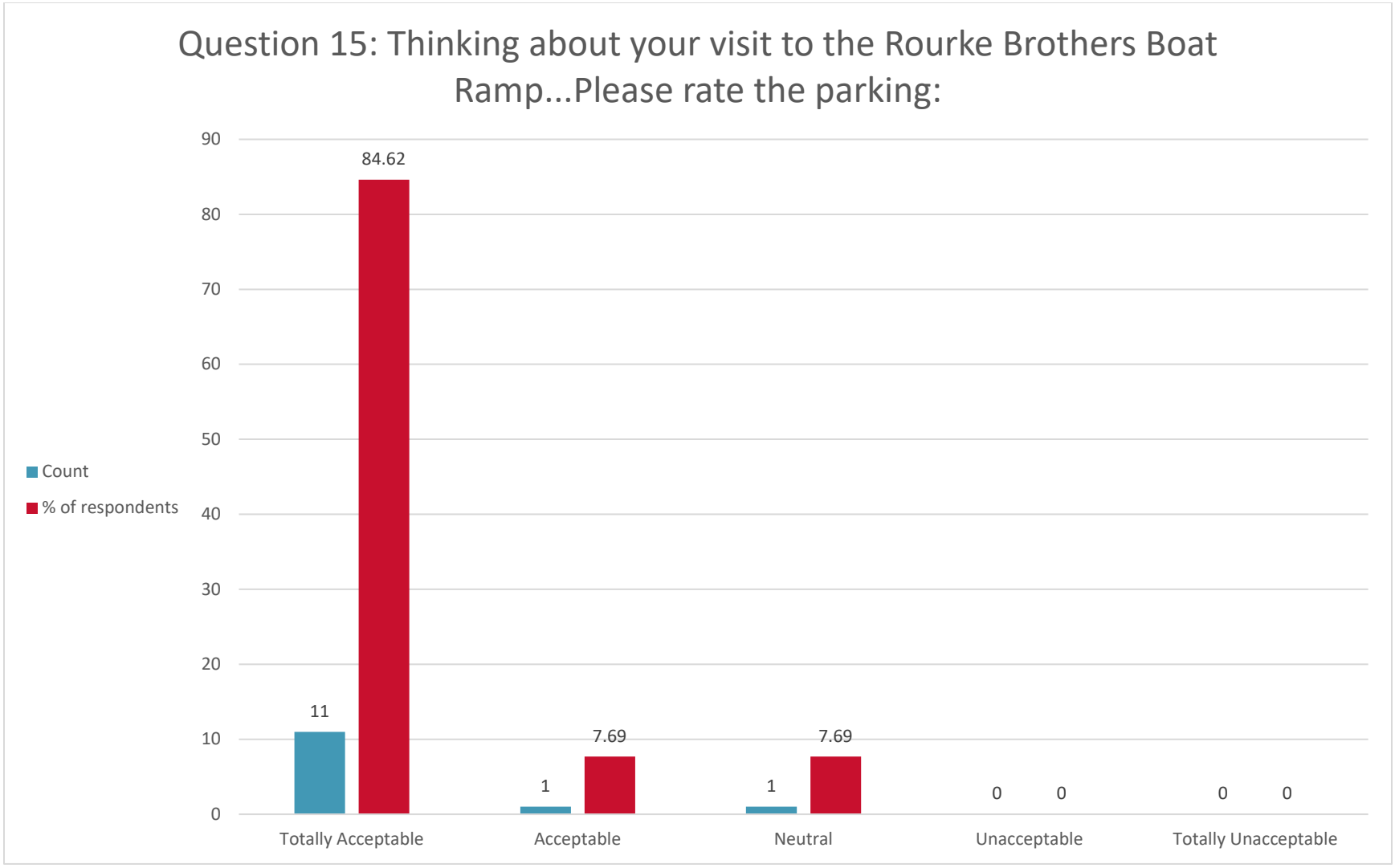


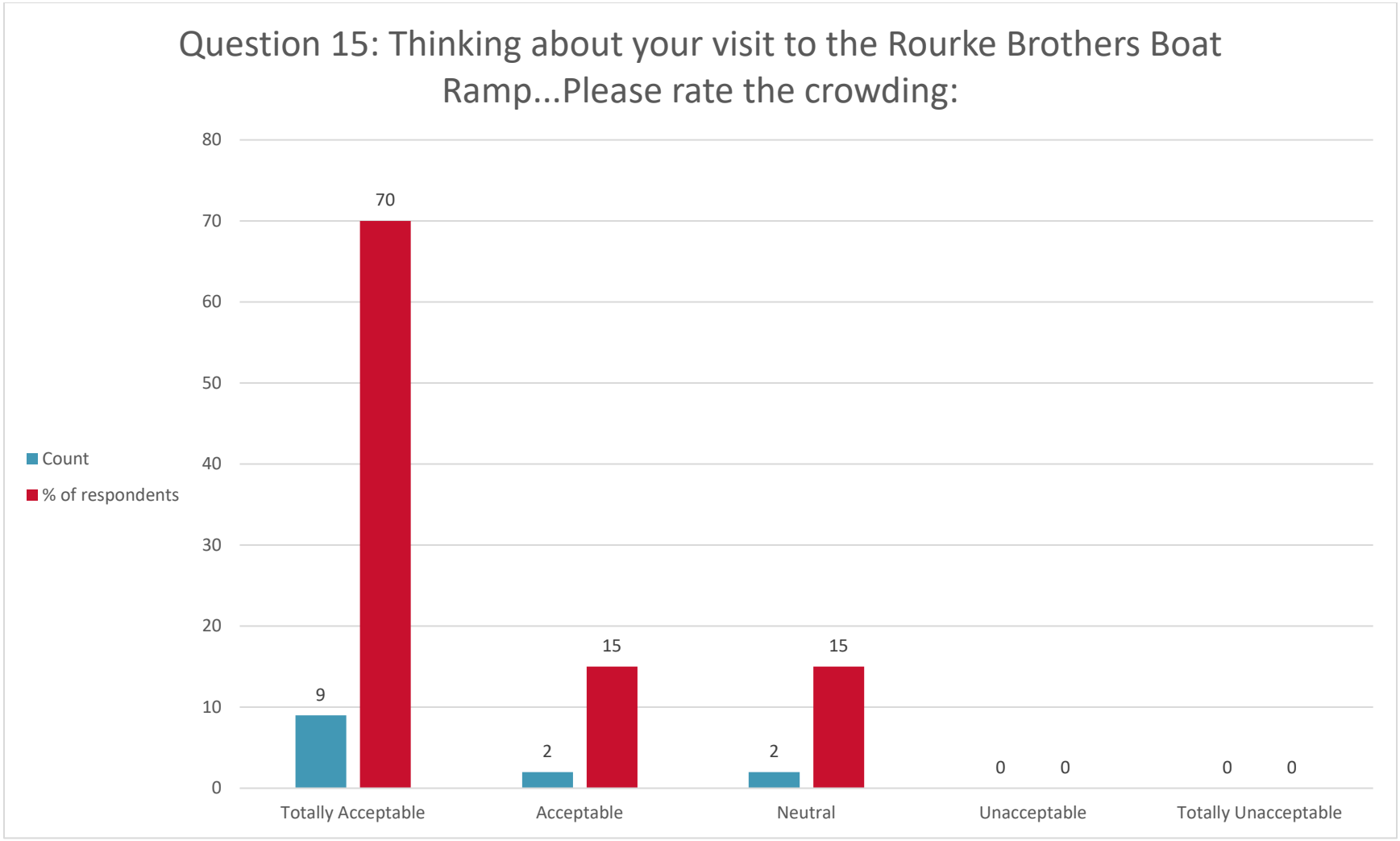
*Percentages not shown for respondent counts under ten.

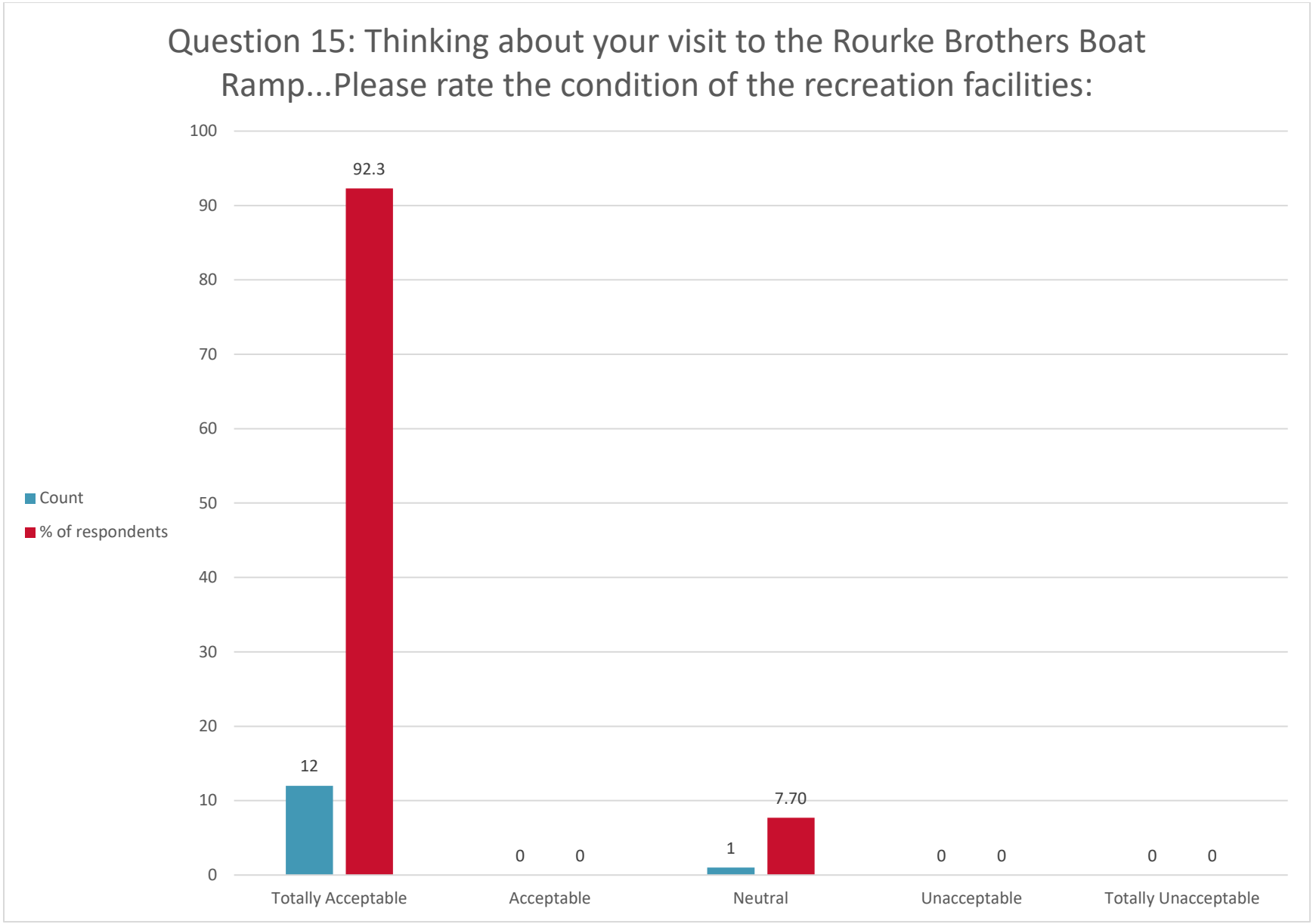


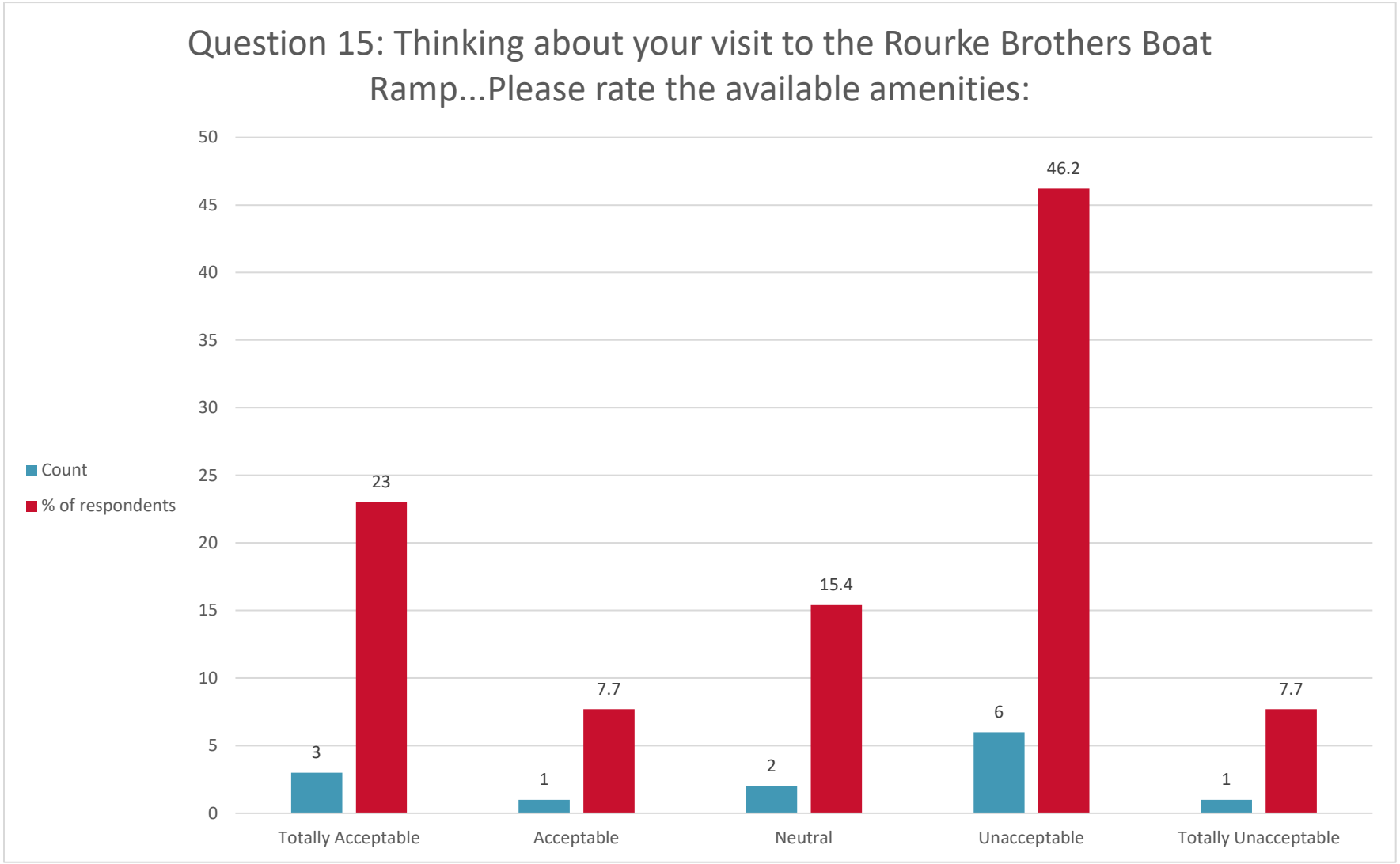
*Percentages not shown for respondent counts under ten.

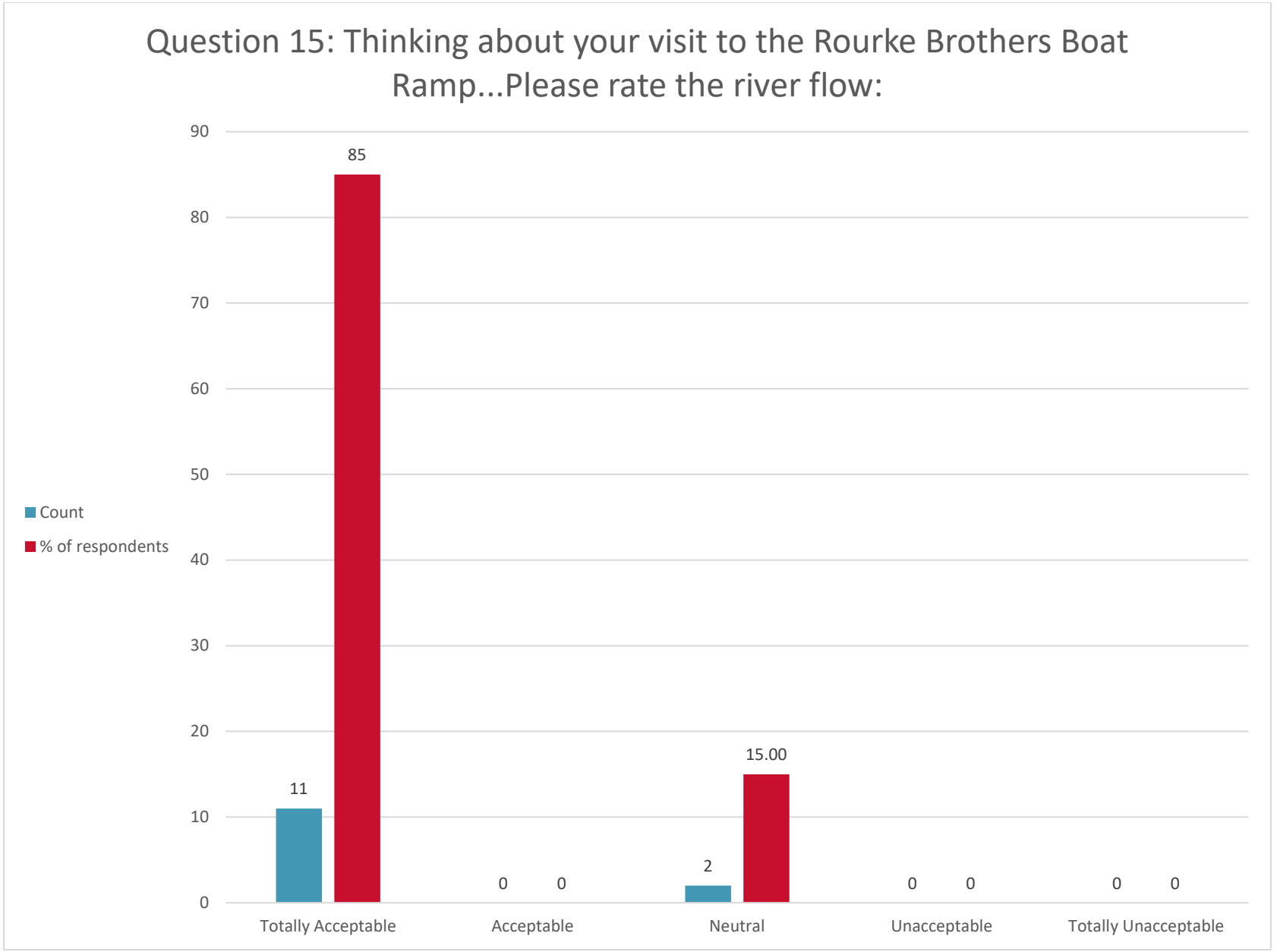

Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the accessibility:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
84.62
11
7.69
1
7.69
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

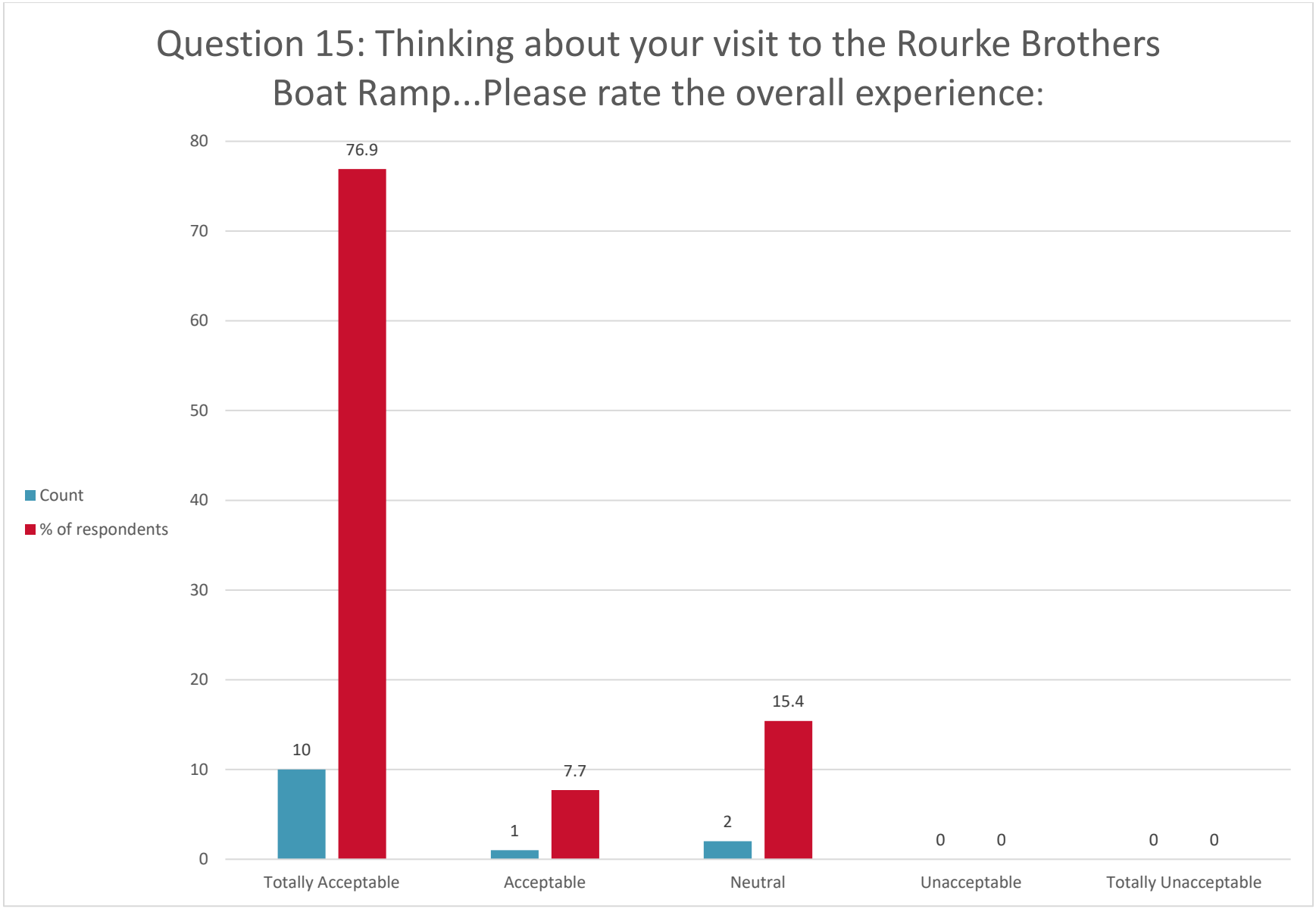

Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the parking:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
84.62
11
7.69
1
7.69
1
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

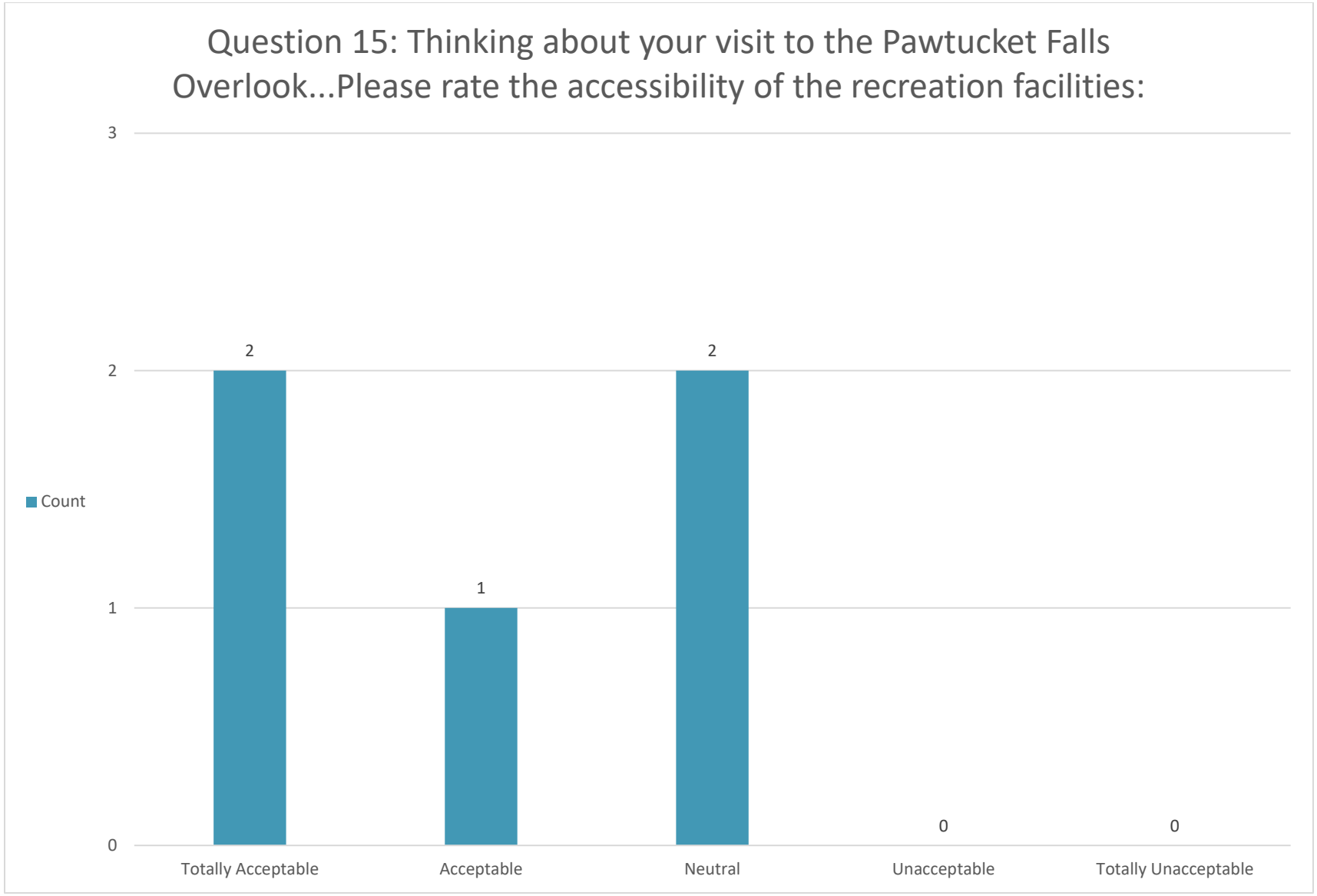

Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the crowding:
80
70
60
50
40
30
20
10
0
Count
% of respondents
9
70
2
15
2
15
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the condition of the recreation facilities:
100
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
92.3
12
0
0
1
7.70
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

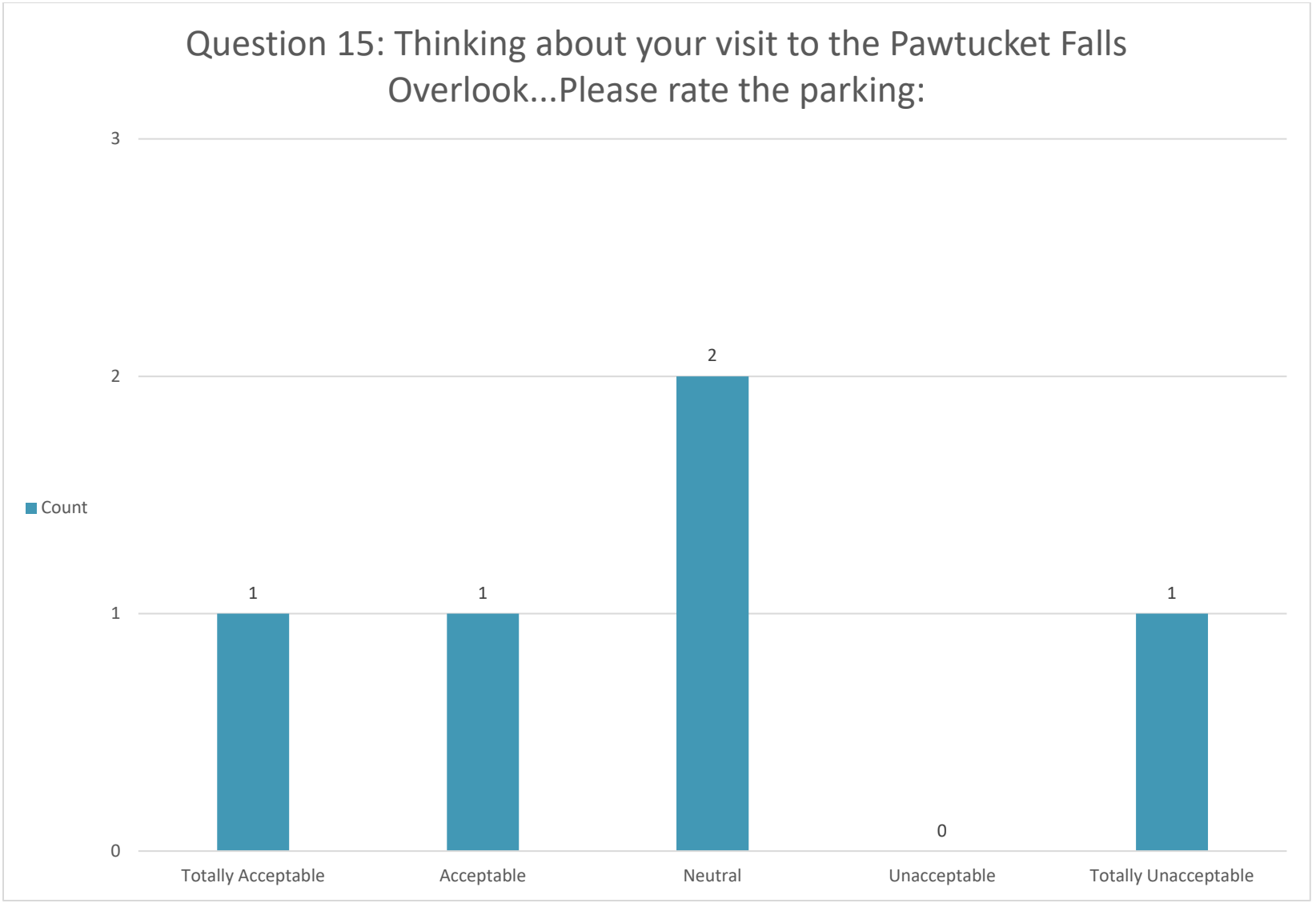

Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the available amenities:
50
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
3
23
1
7.7
2
15.4
6
46.2
1
7.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the river flow:
90
80
70
60
50
40
30
20
10
0
Count
% of respondents
85
11
0
0
2
15.00
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

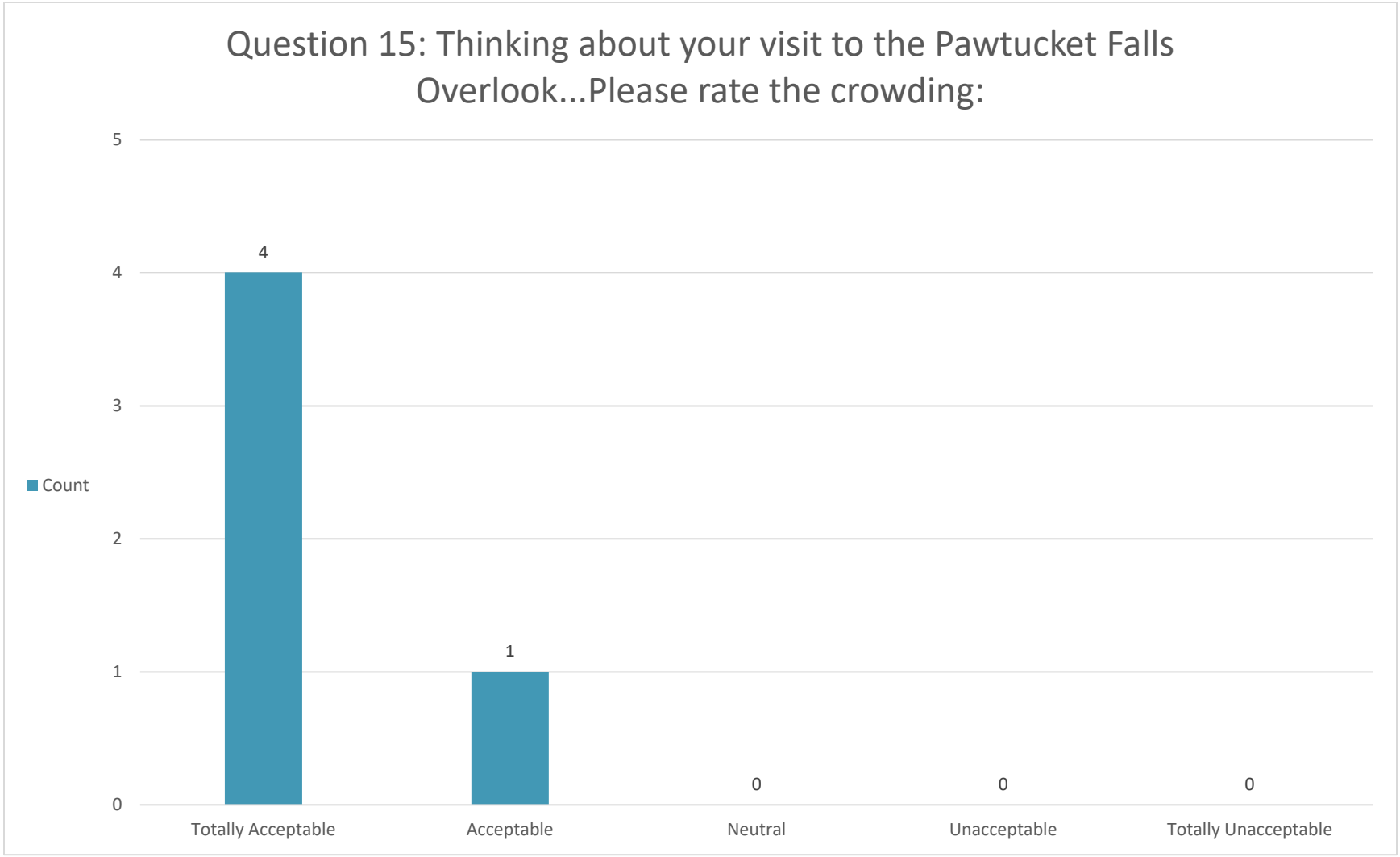

Question 15: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the overall experience:
80
70
60
50
40
30
20
10
0
Count
% of respondents
76.9
10
7.7
1
15.4
2
0
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable



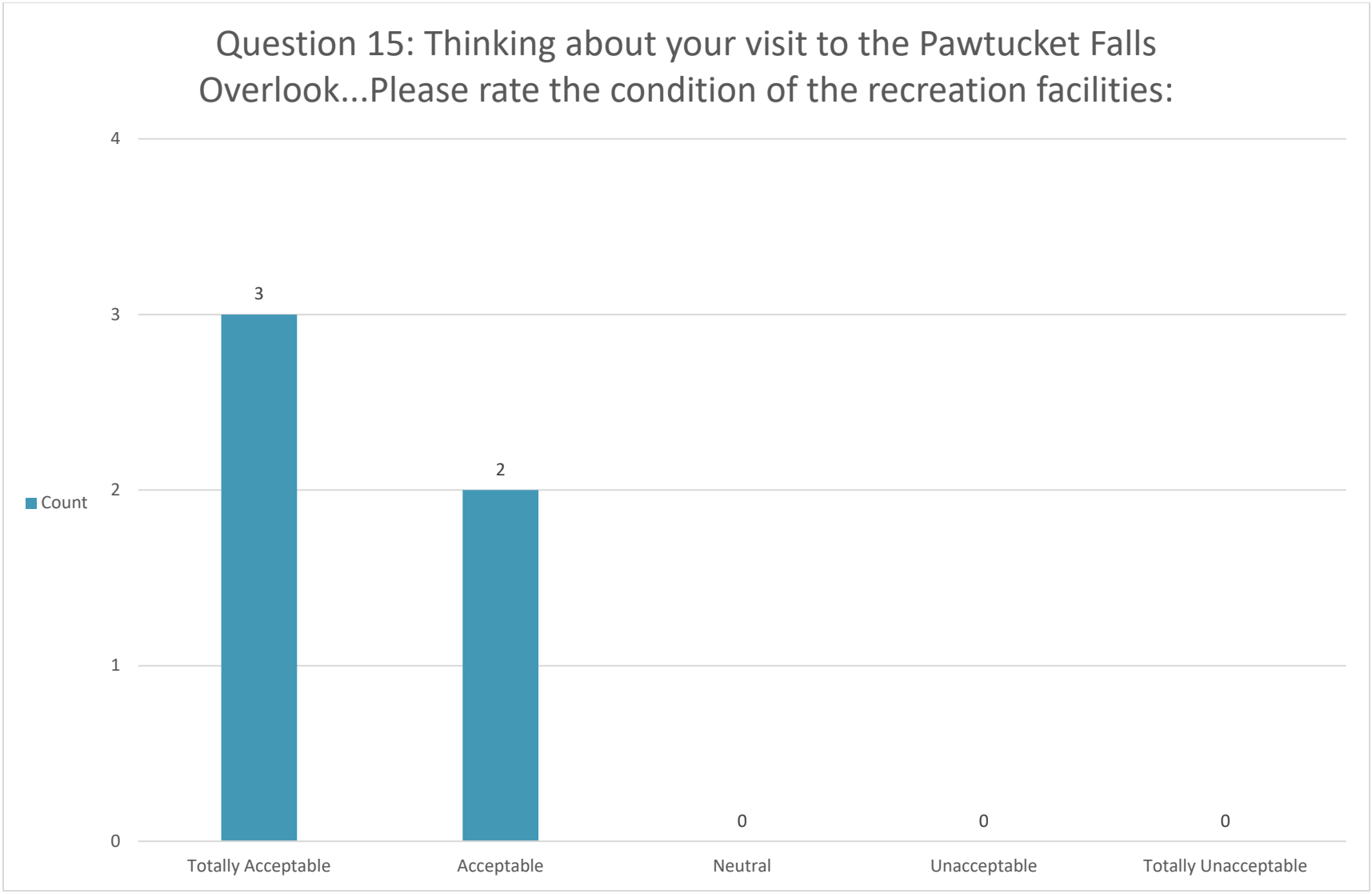
*Percentages not shown for respondent counts under ten.



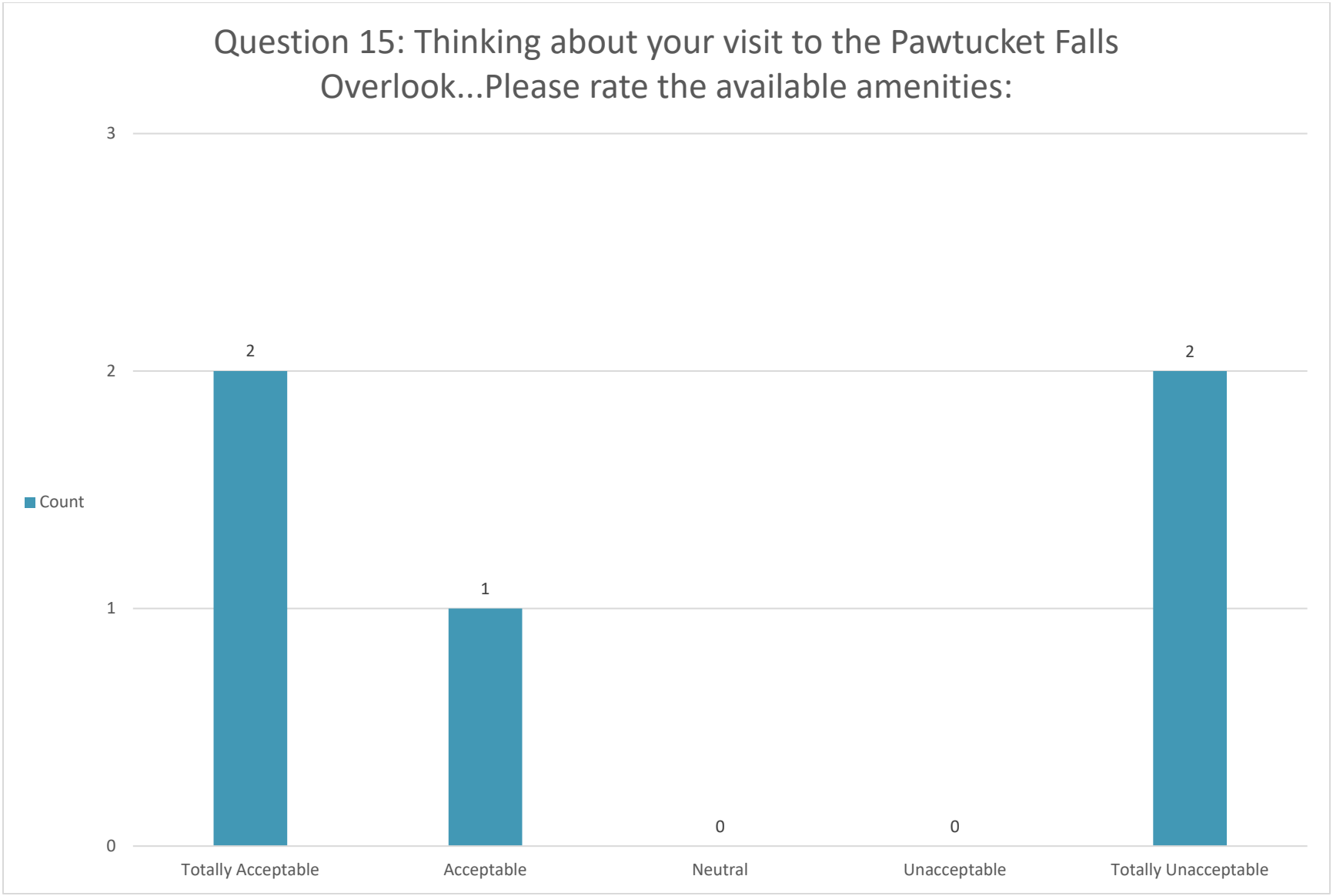
*Percentages not shown for respondent counts under ten.



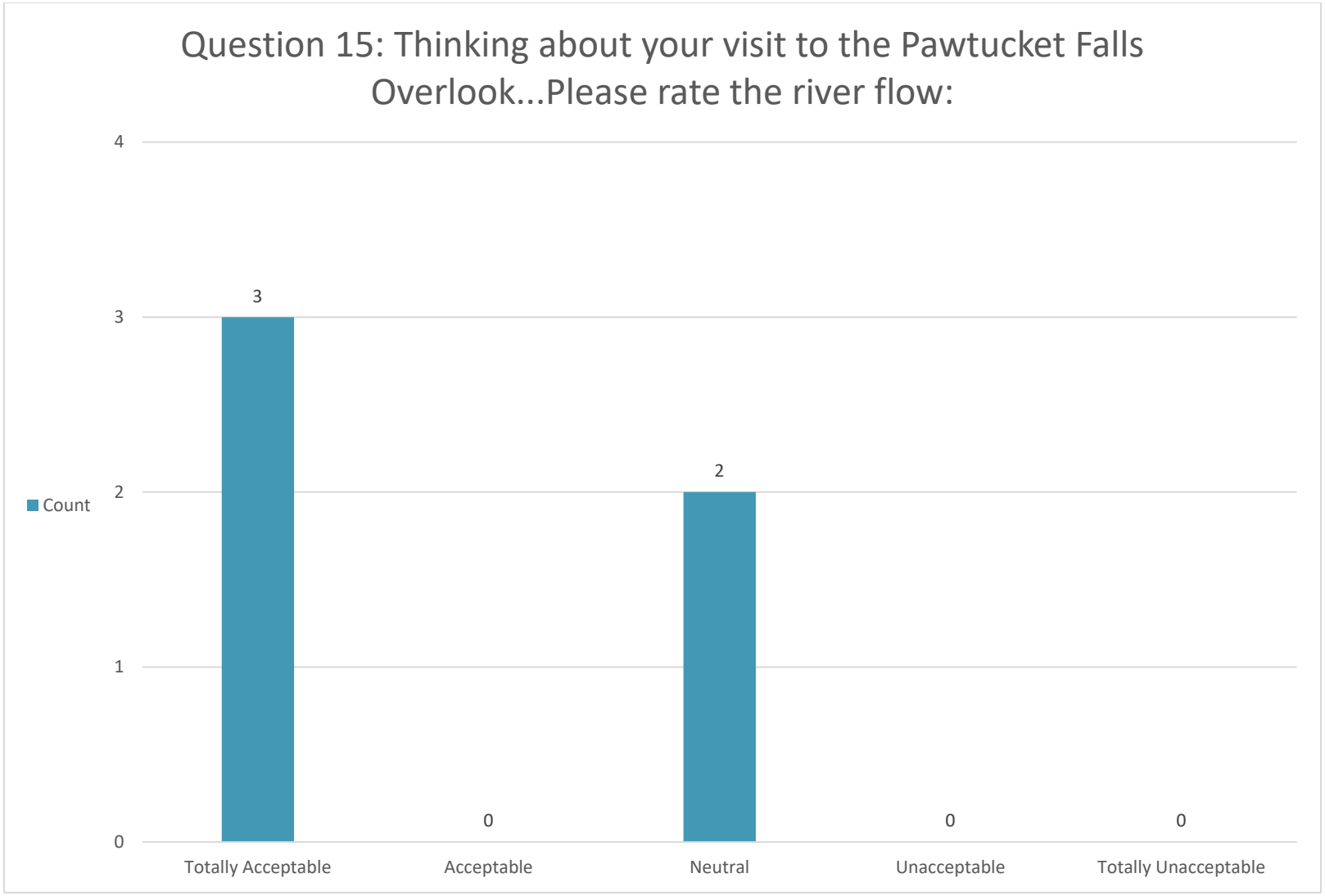
*Percentages not shown for respondent counts under ten.



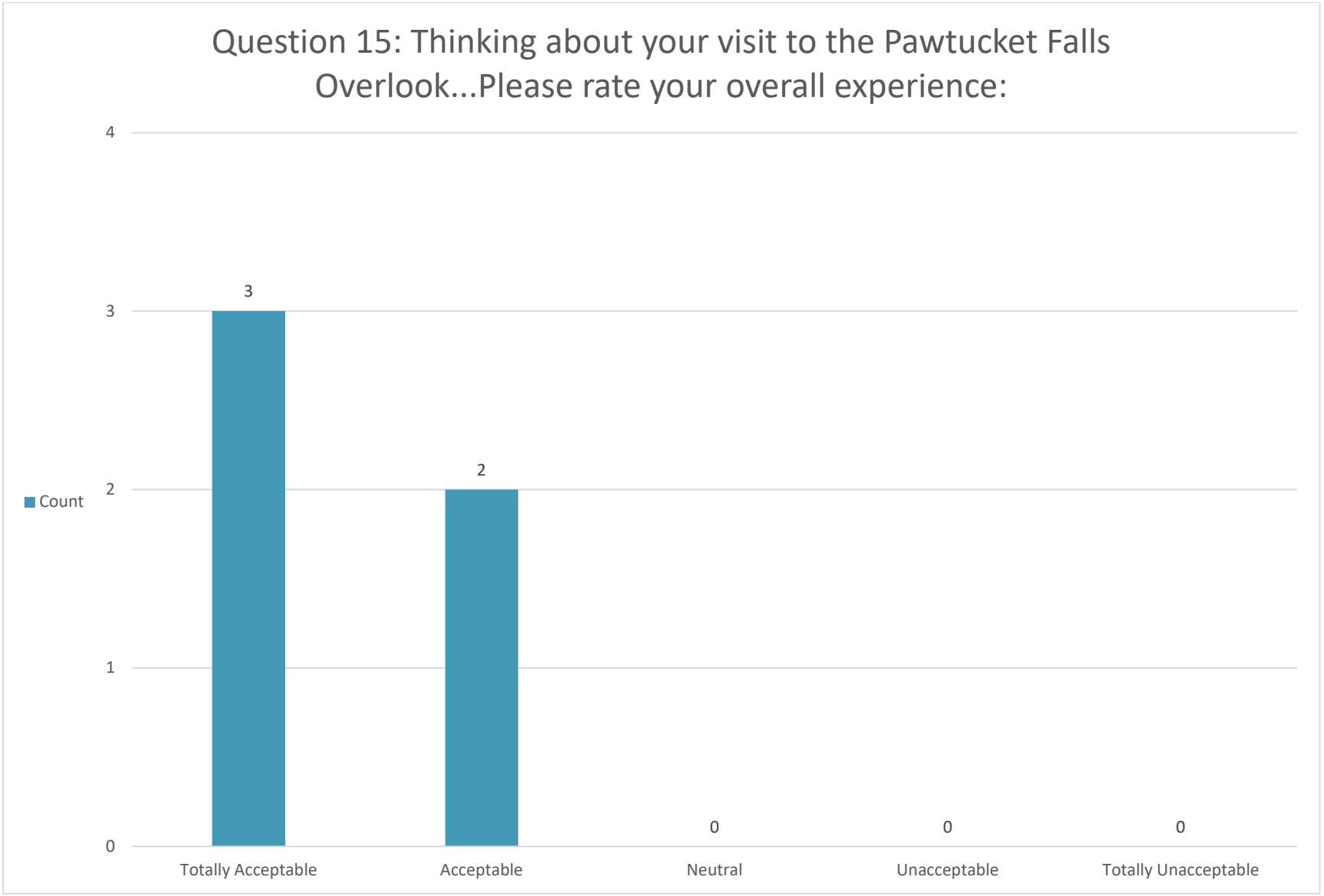
*Percentages not shown for respondent counts under ten.



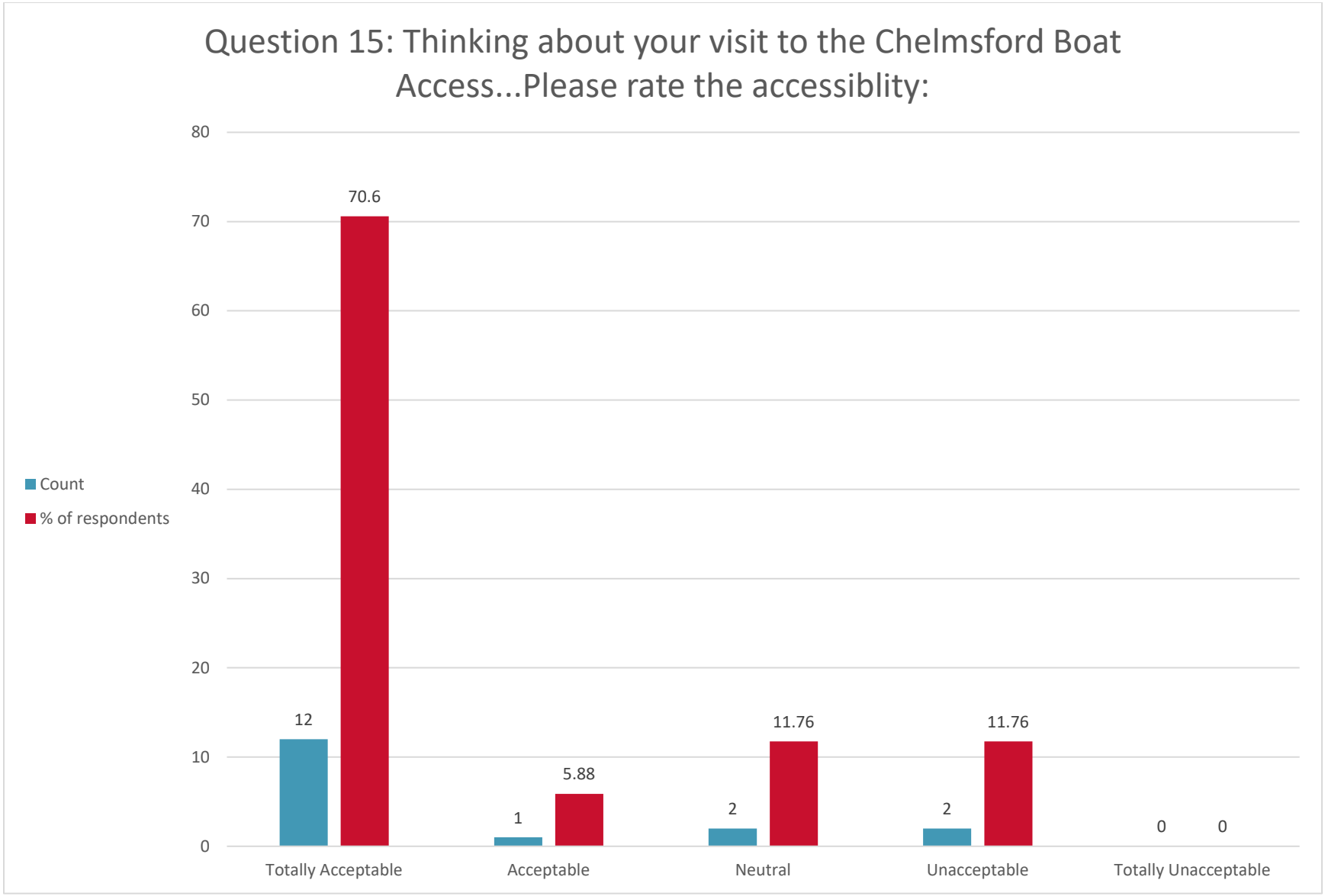
*Percentages not shown for respondent counts under ten.

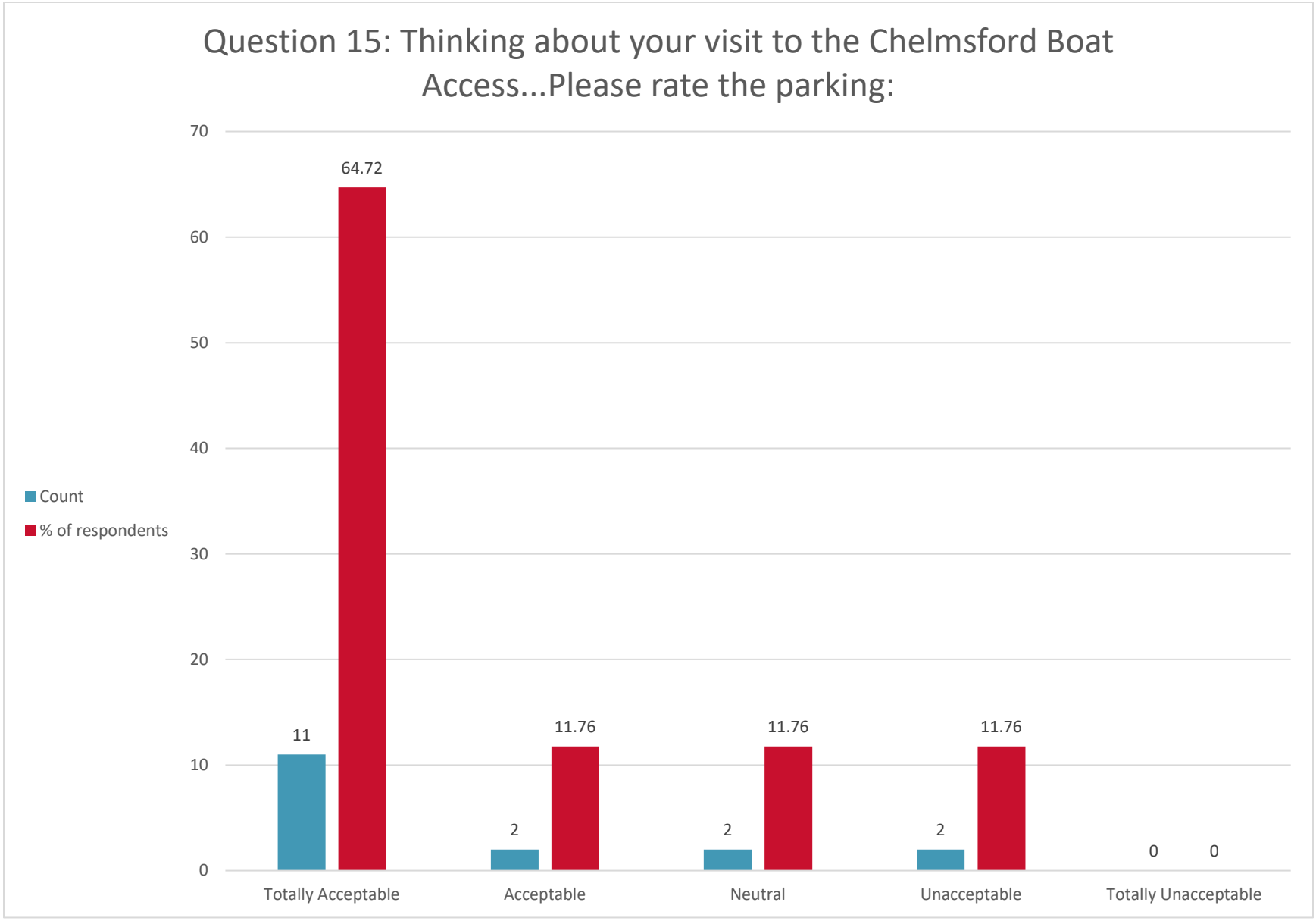


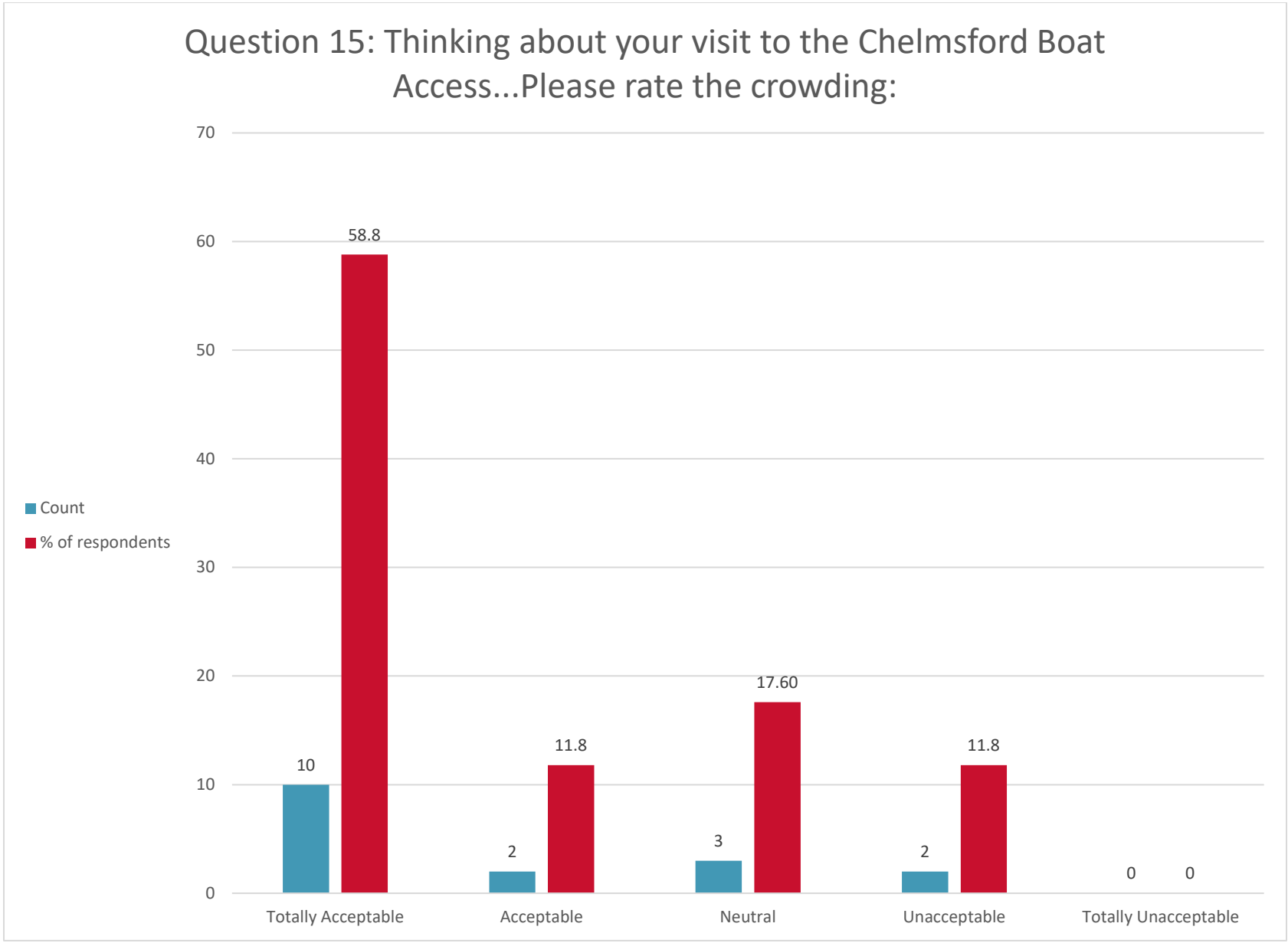
*Percentages not shown for respondent counts under ten.

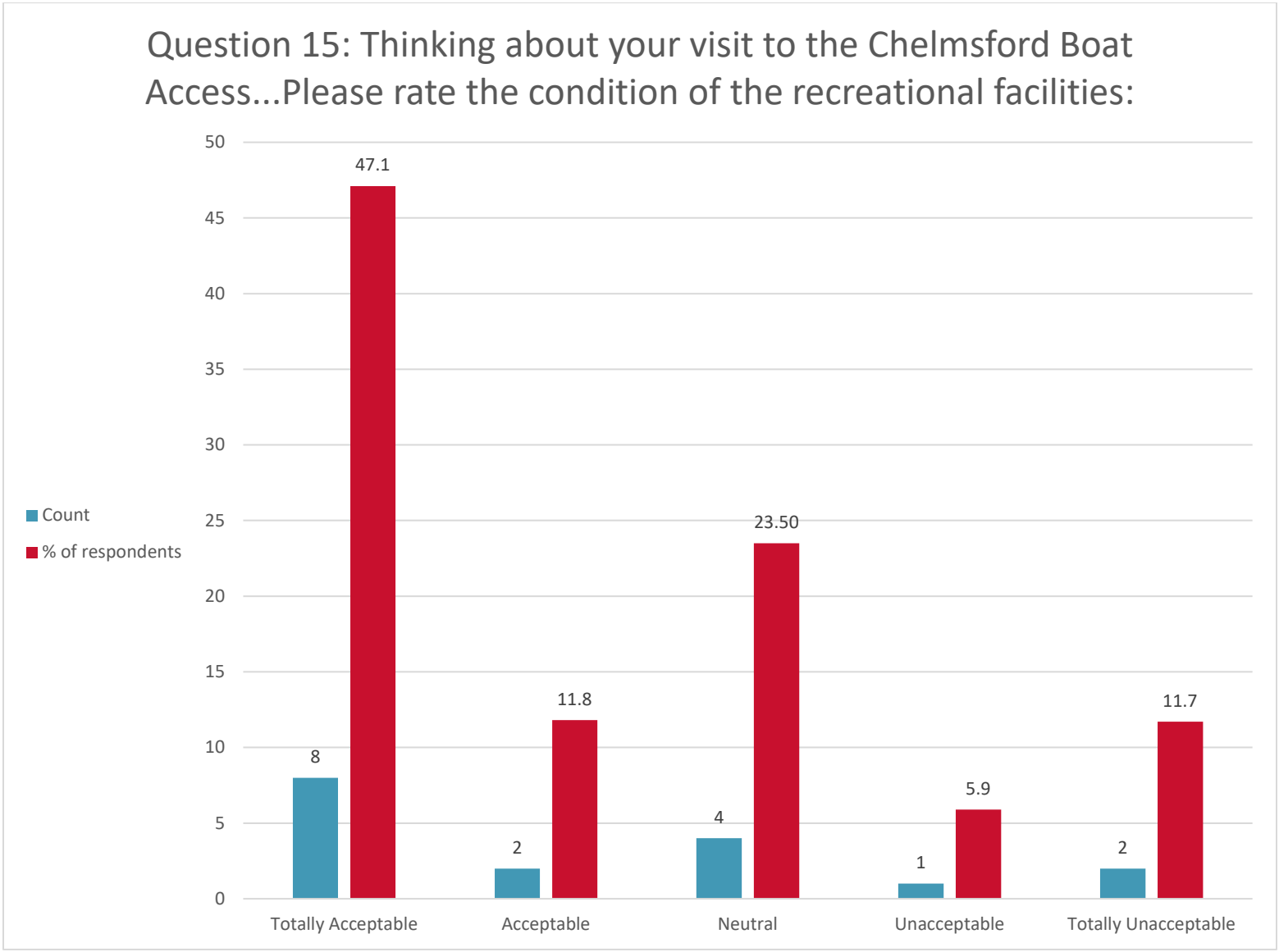


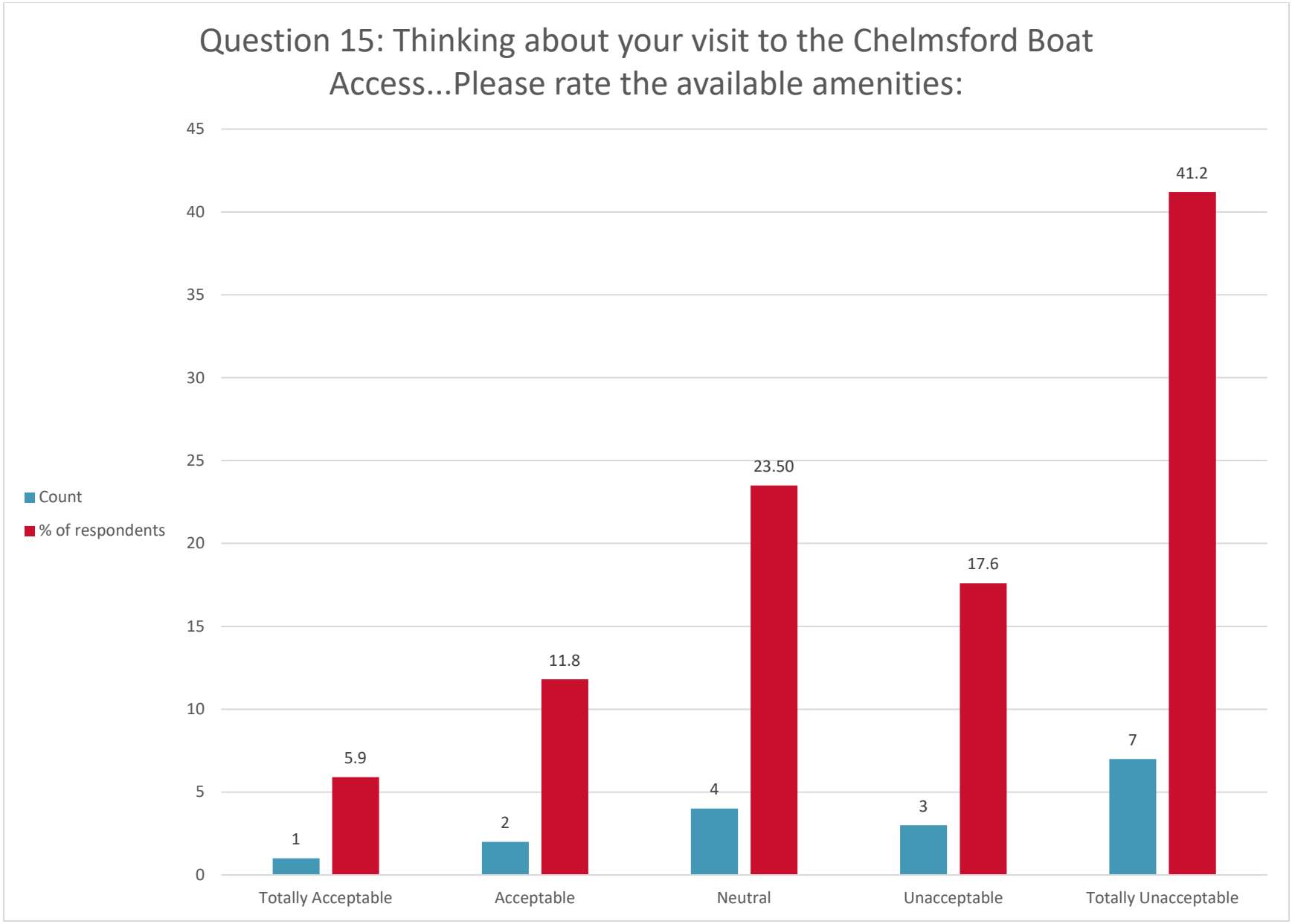
*Percentages not shown for respondent counts under ten.

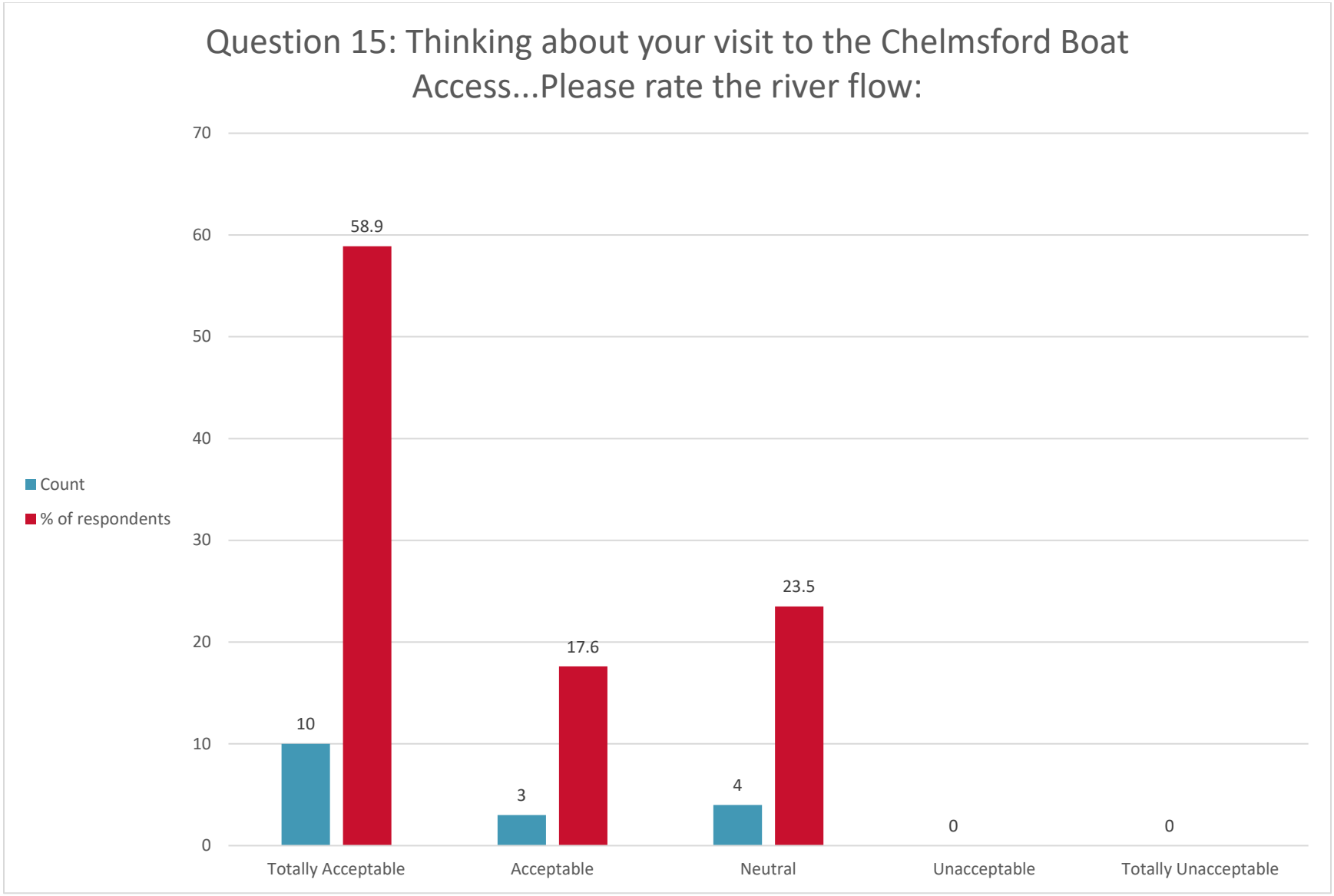

Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the accessiblity:
80
70
60
50
40
30
20
10
0
Count
% of respondents
70.6
12
5.88
1
11.76
2
11.76
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

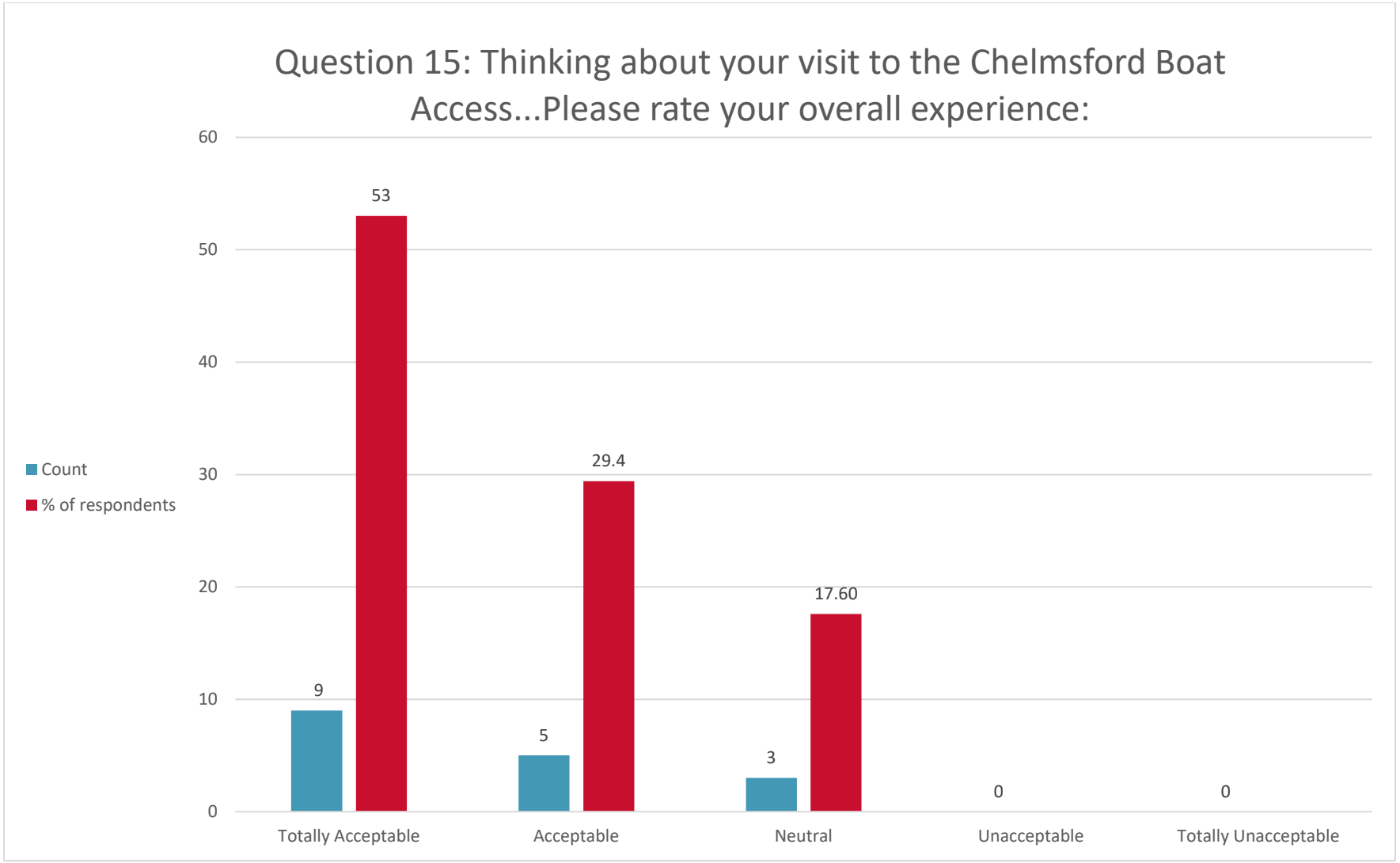

Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the parking:
70
60
50
40
30
20
10
0
Count
% of respondents
64.72
11
11.76
2
11.76
2
11.76
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

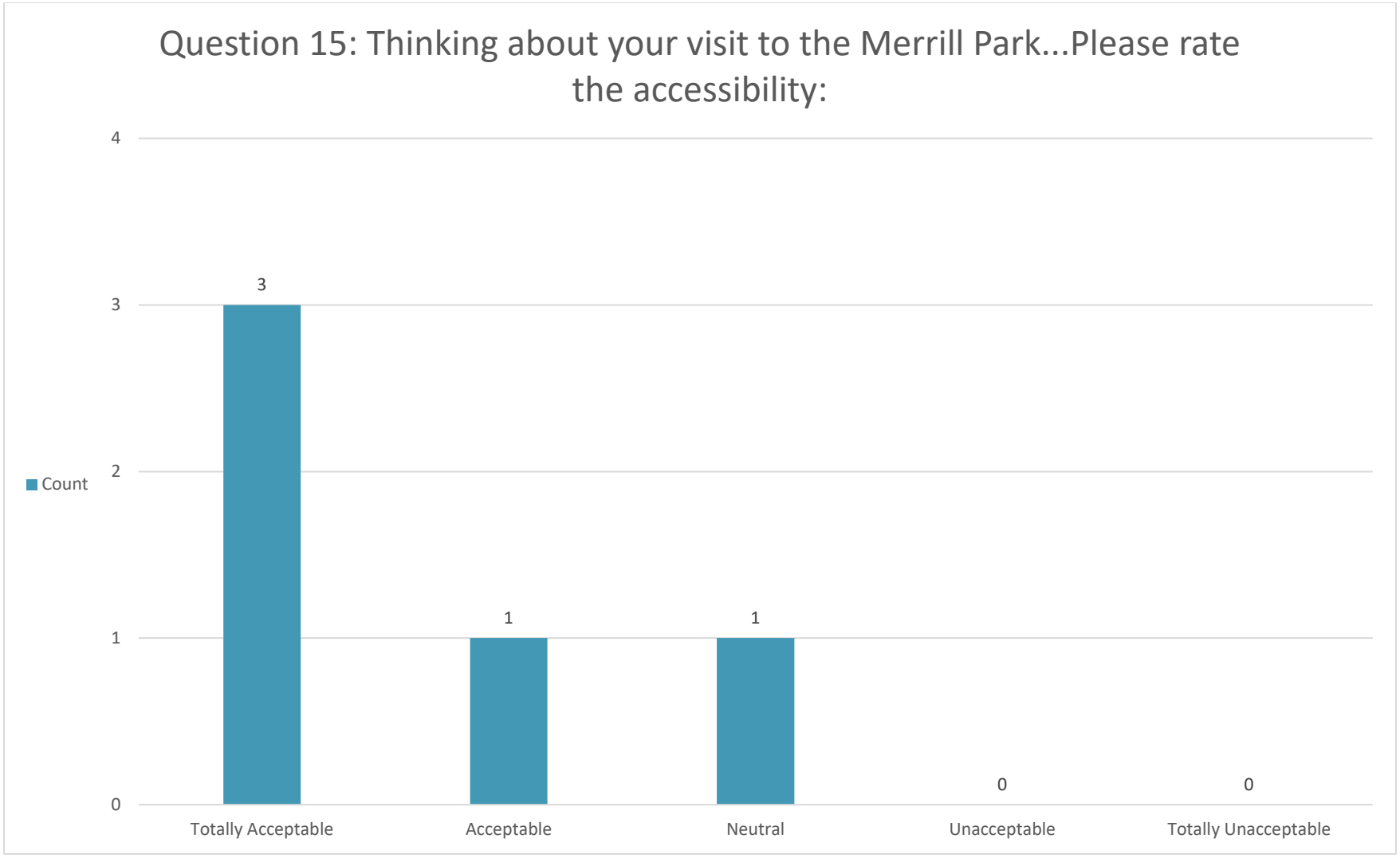

Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the crowding:
70
60
50
40
30
20
10
0
Count
% of respondents
58.8
10
11.8
2
17.60
3
11.8
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the condition of the recreational facilities:
50
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
47.1
8
11.8
2
23.50
4
5.9
1
11.7
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

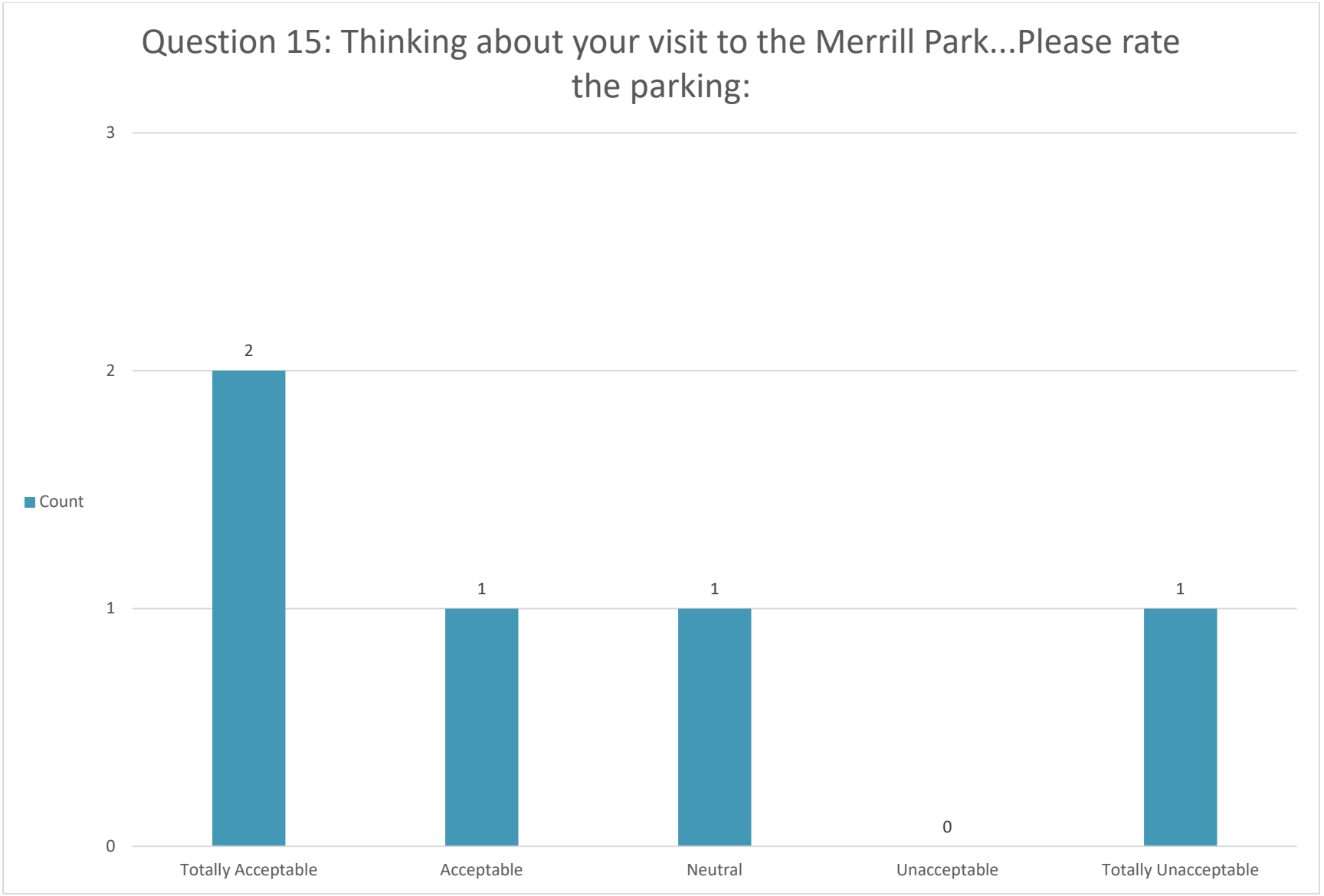

Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the available amenities:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
1
5.9
2
11.8
4
23.50
3
17.6
7
41.2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate the river flow:
70
60
50
40
30
20
10
0
Count
% of respondents
58.9
17.6
23.5
10
3
4
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

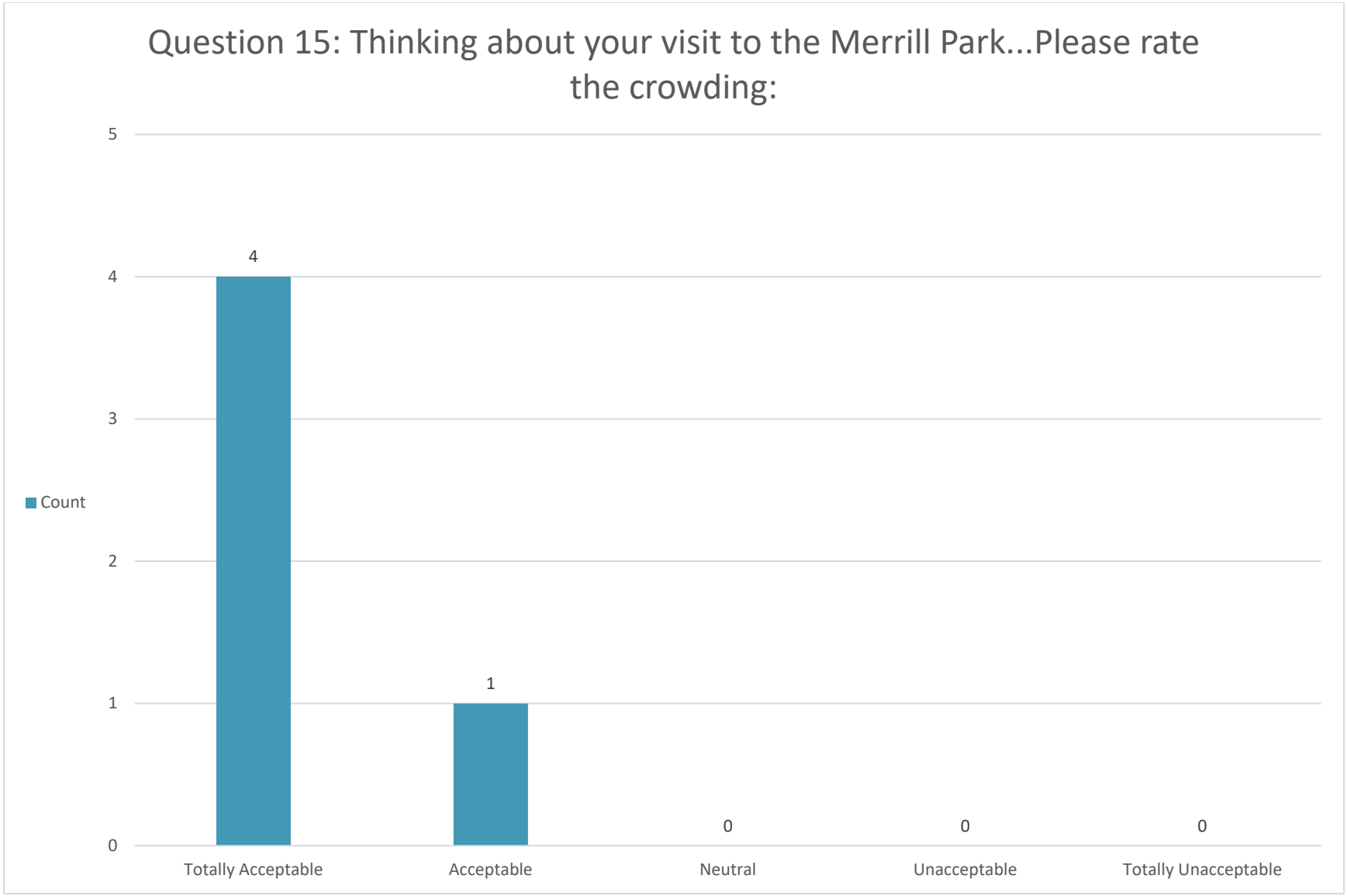

Question 15: Thinking about your visit to the Chelmsford Boat Access...Please rate your overall experience:
60
50
40
30
20
10
0
Count
% of respondents
53
29.4
17.60
9
5
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable



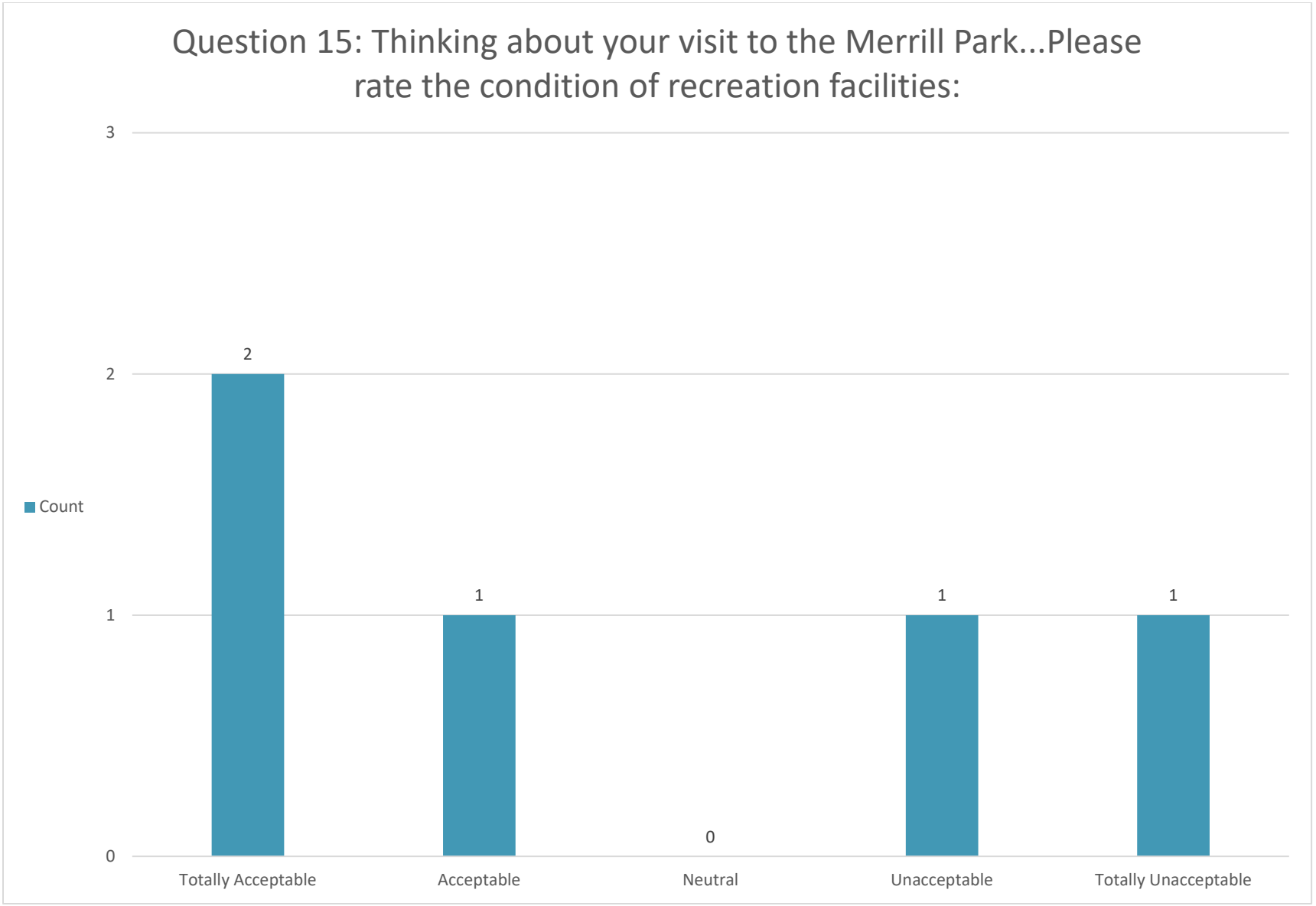
*Percentages not shown for respondent counts under ten.



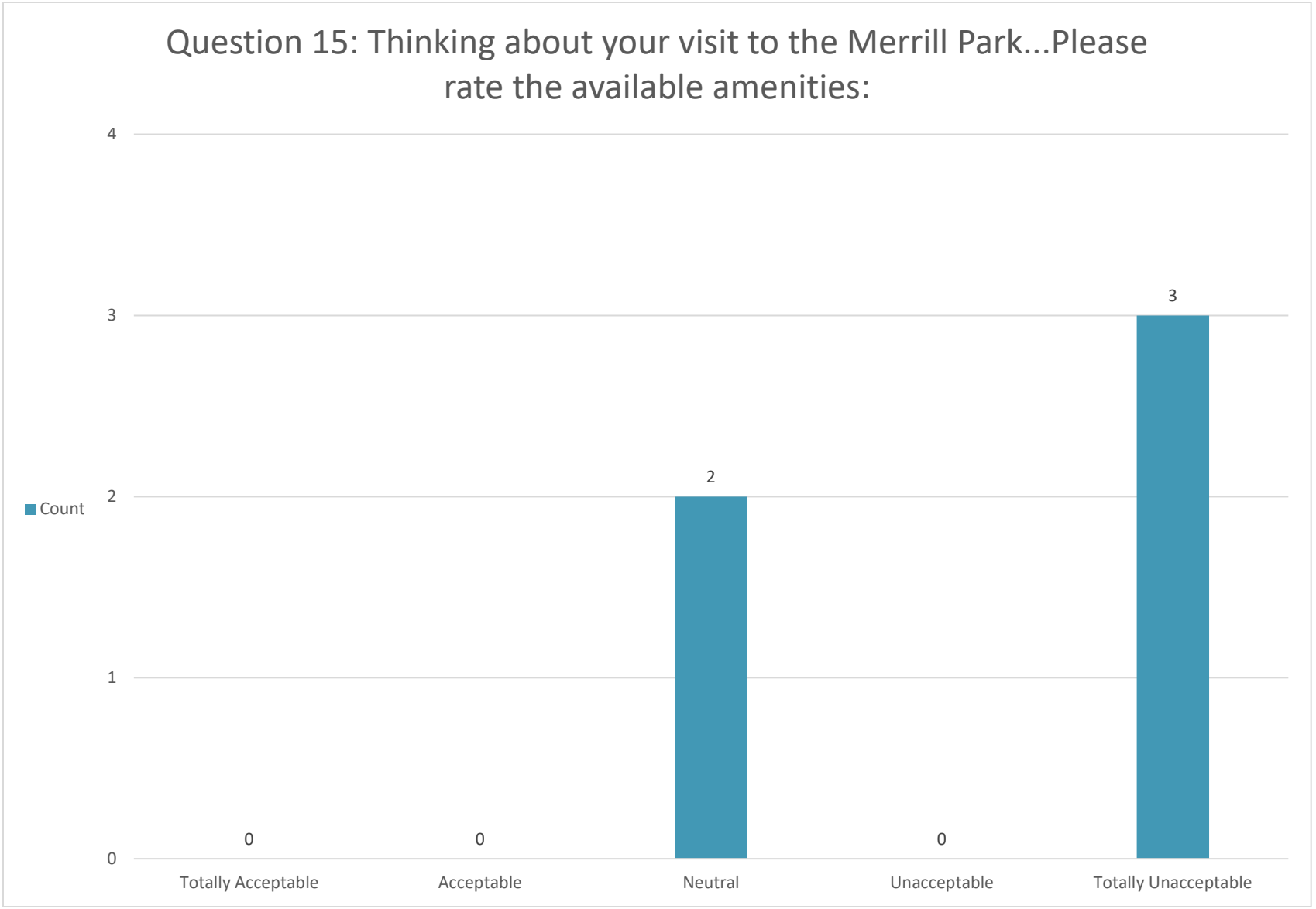
*Percentages not shown for respondent counts under ten.



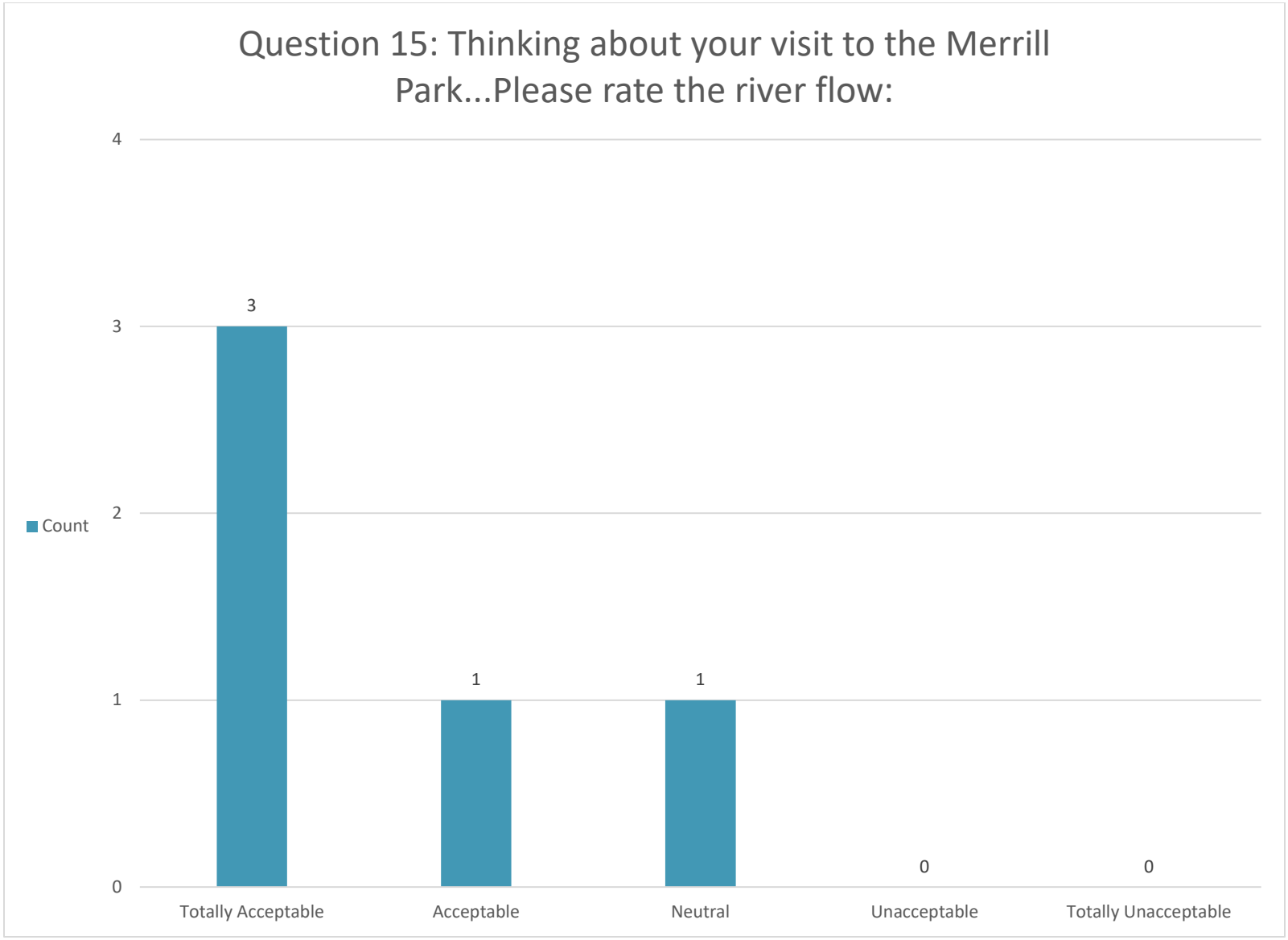
*Percentages not shown for respondent counts under ten.



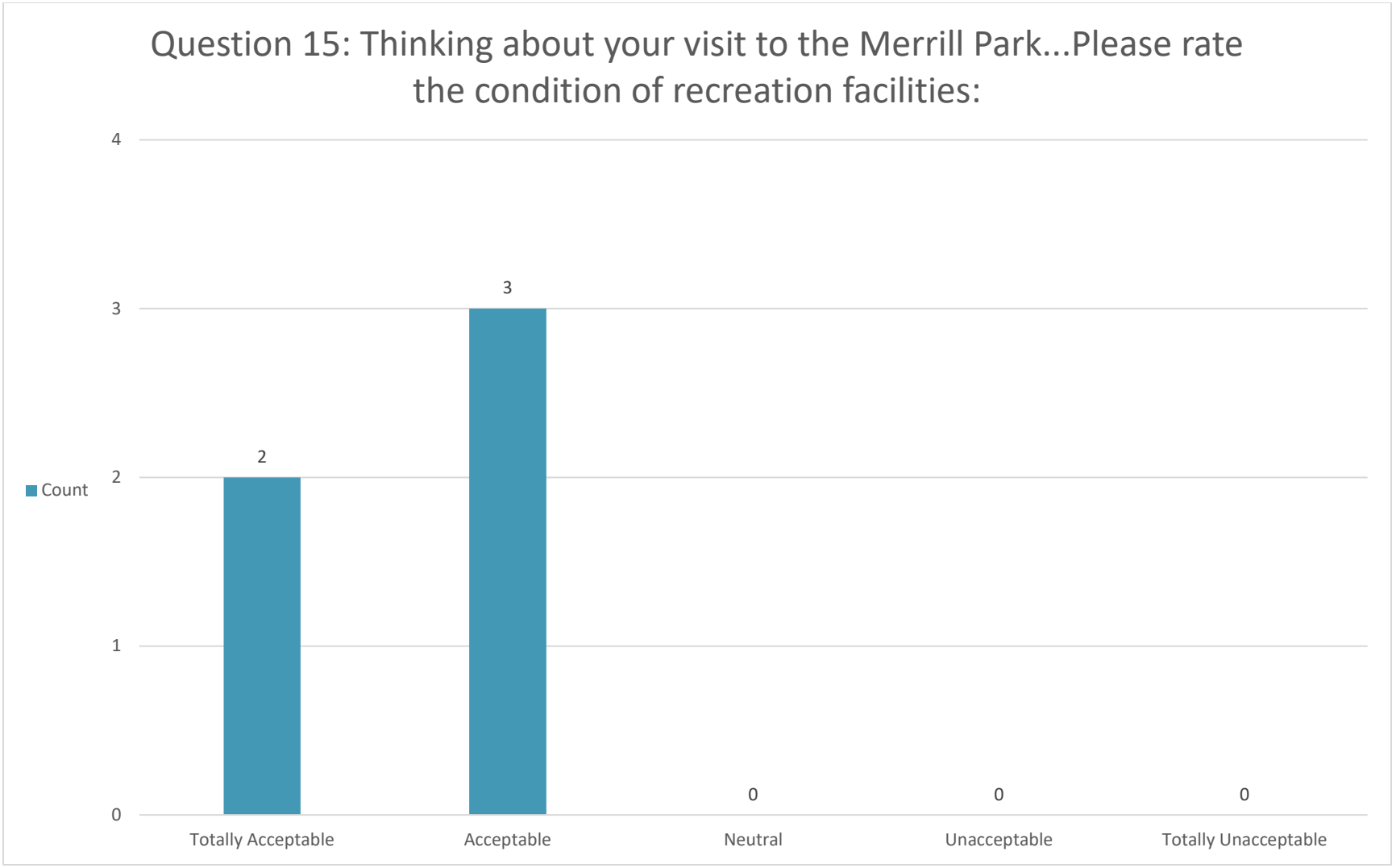
*Percentages not shown for respondent counts under ten.



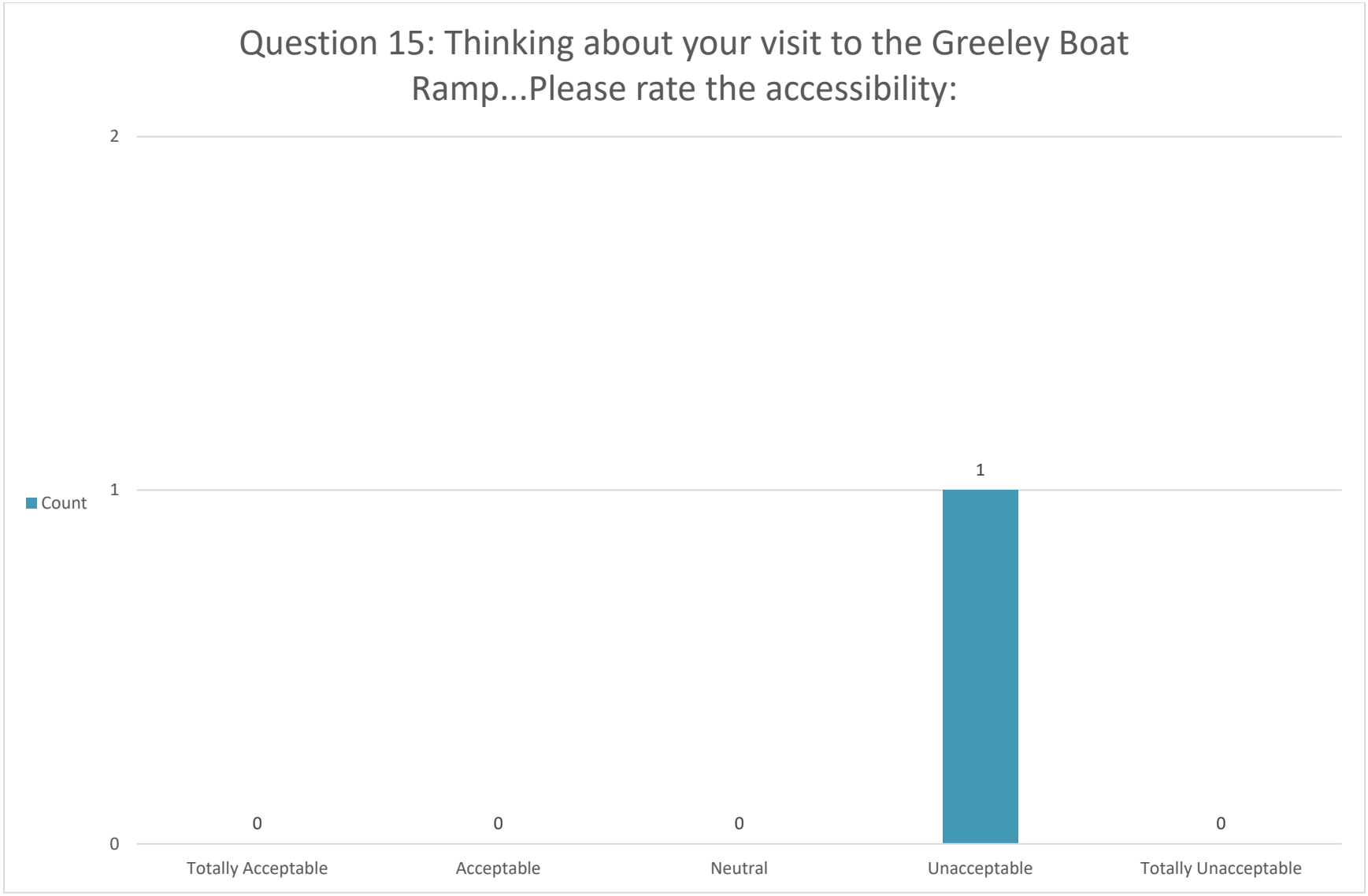
*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



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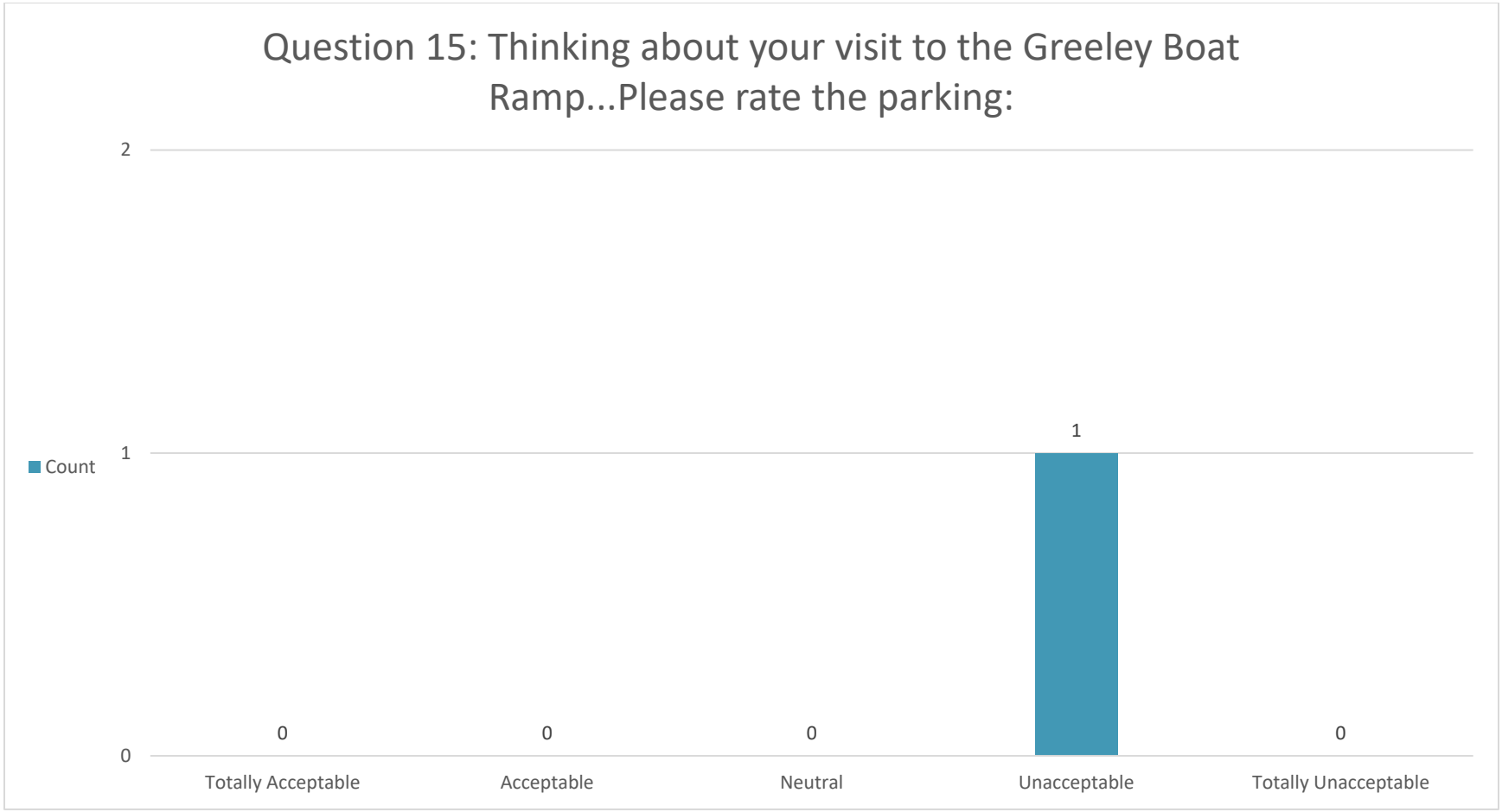

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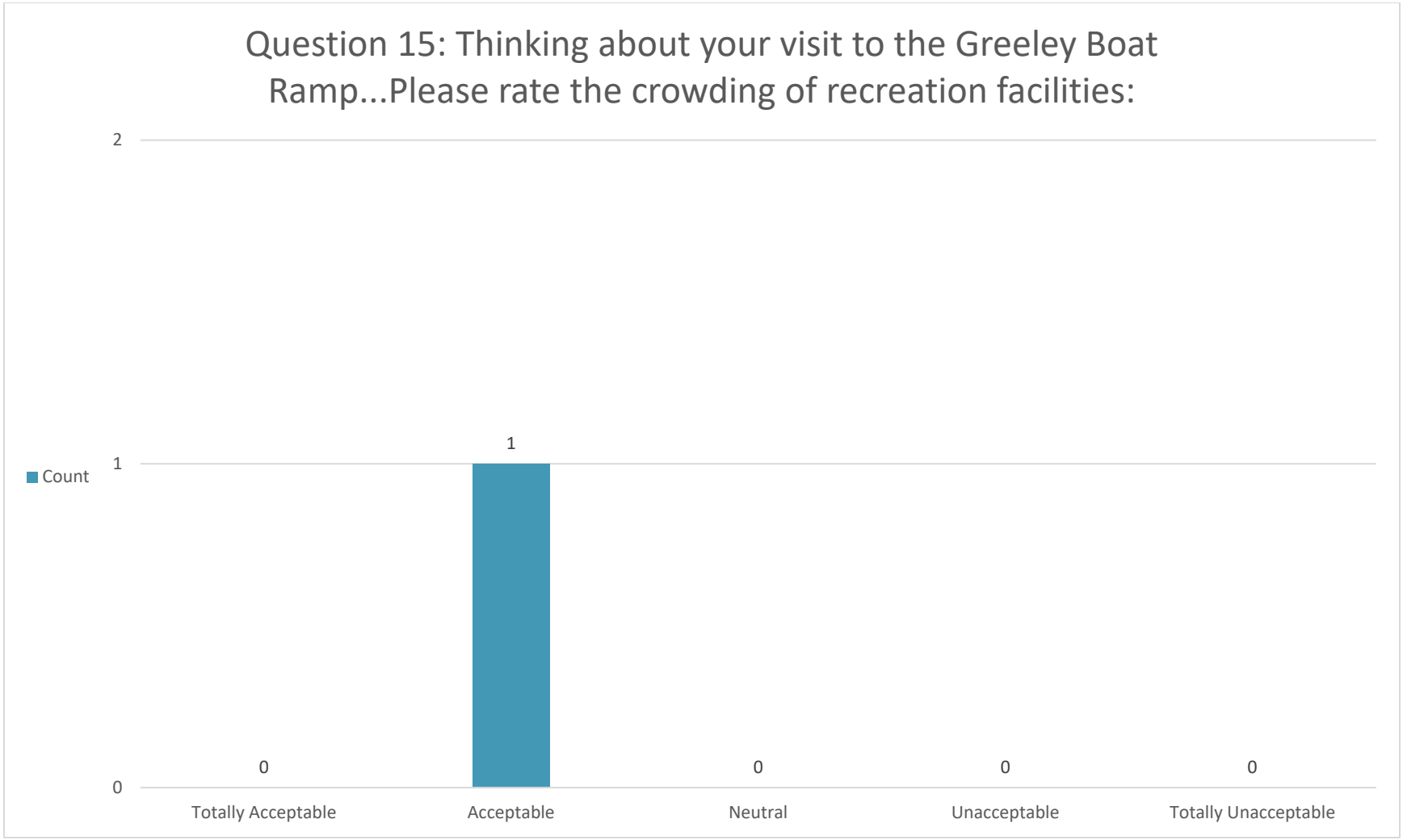

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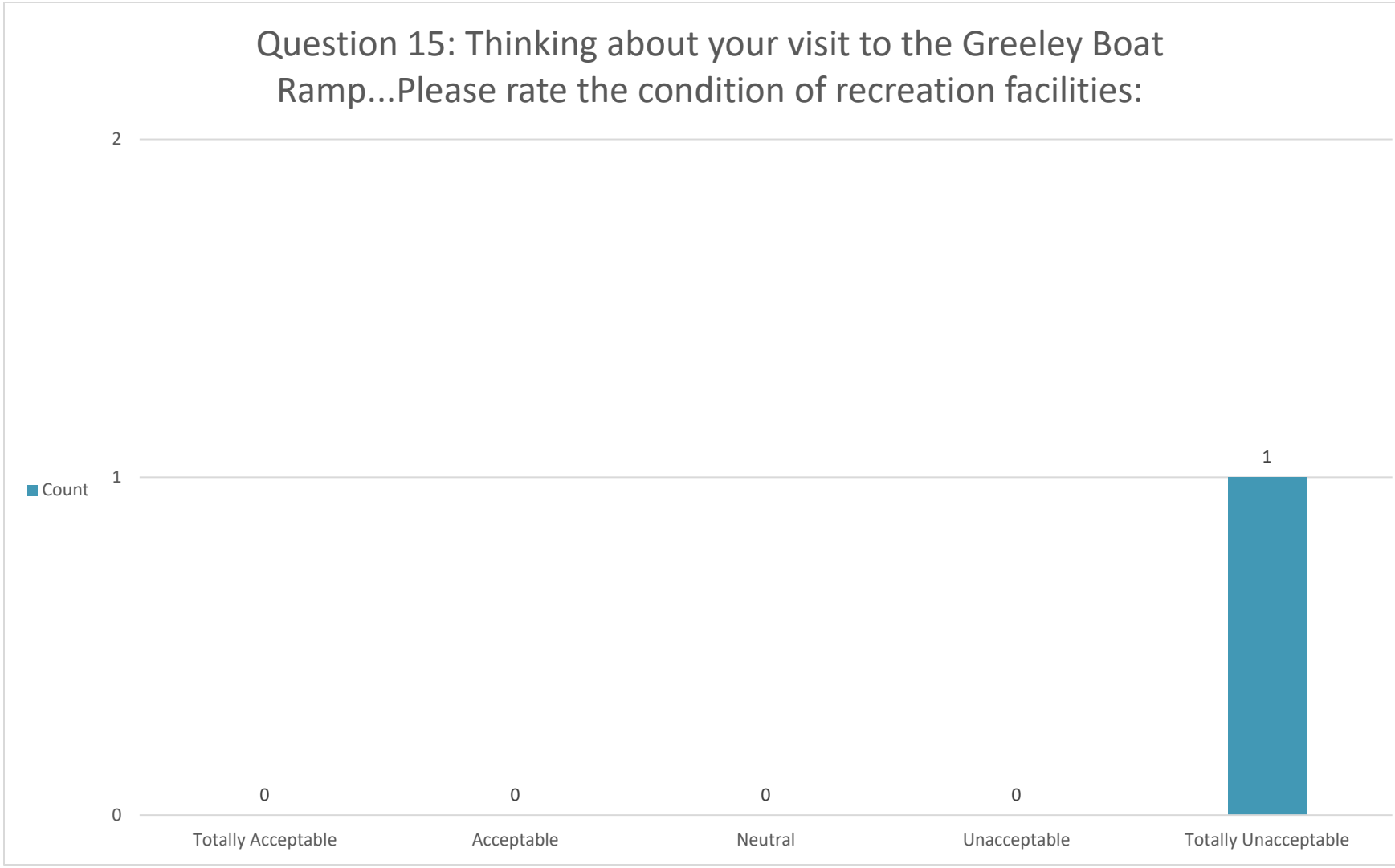
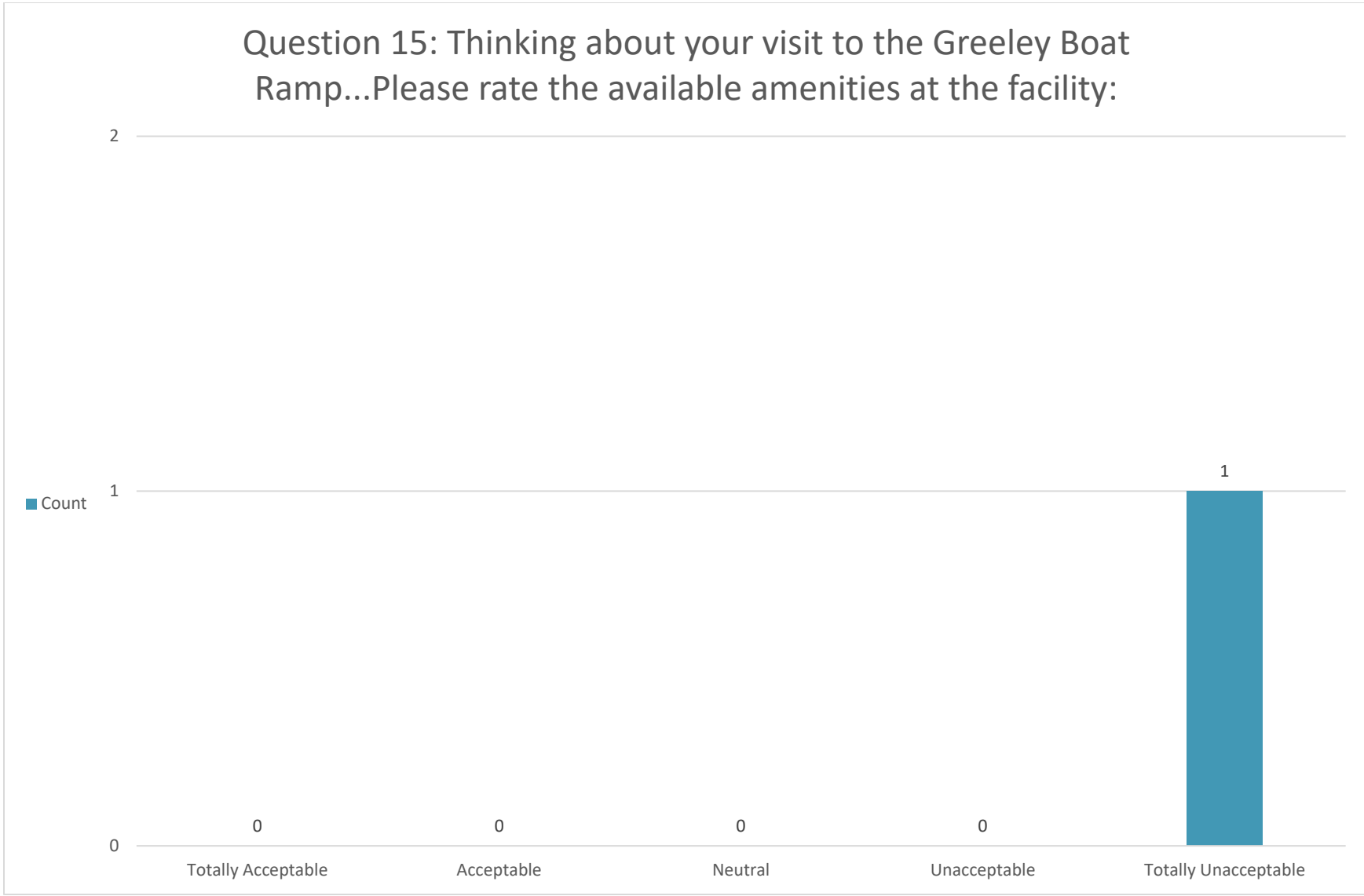
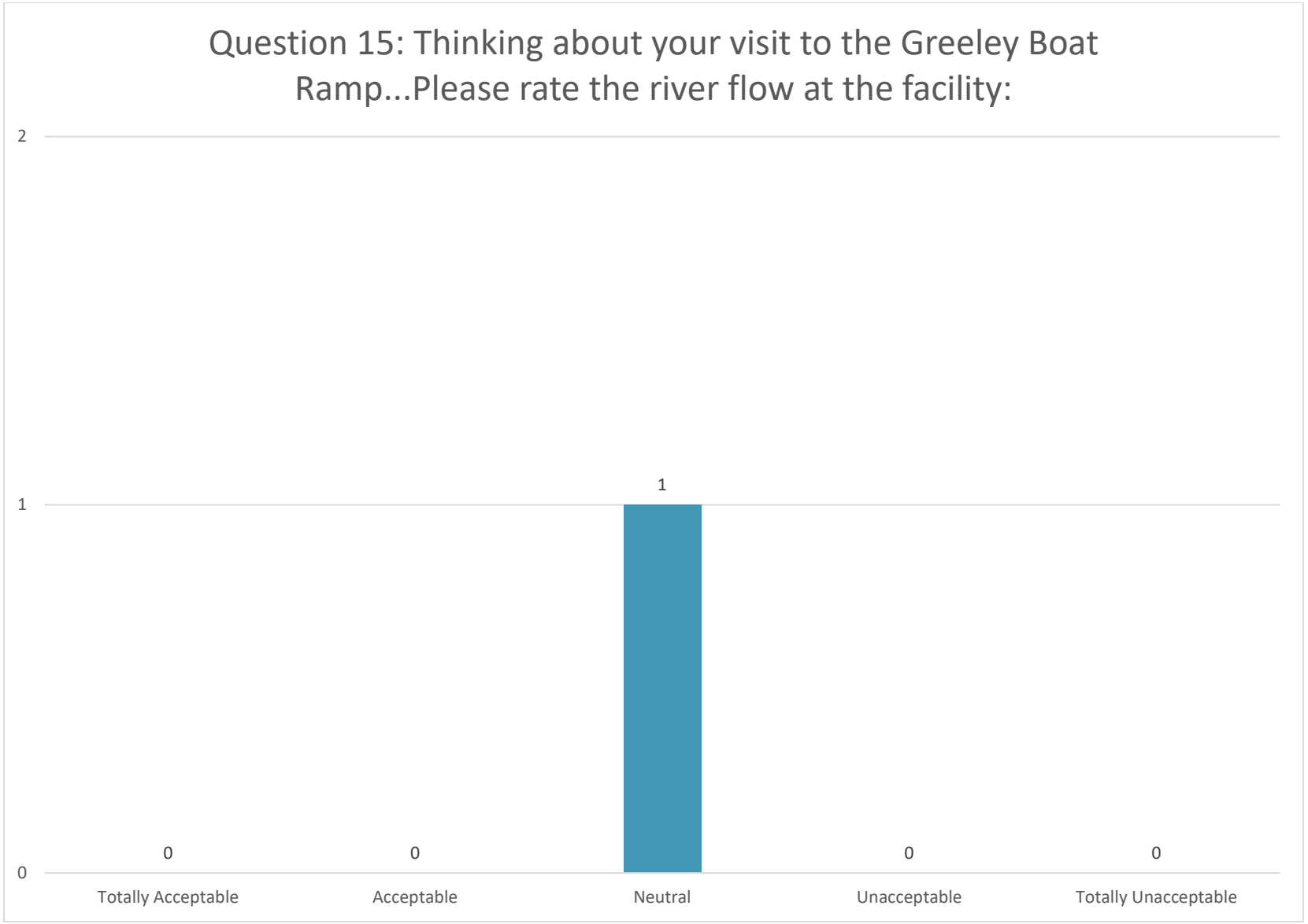


*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.



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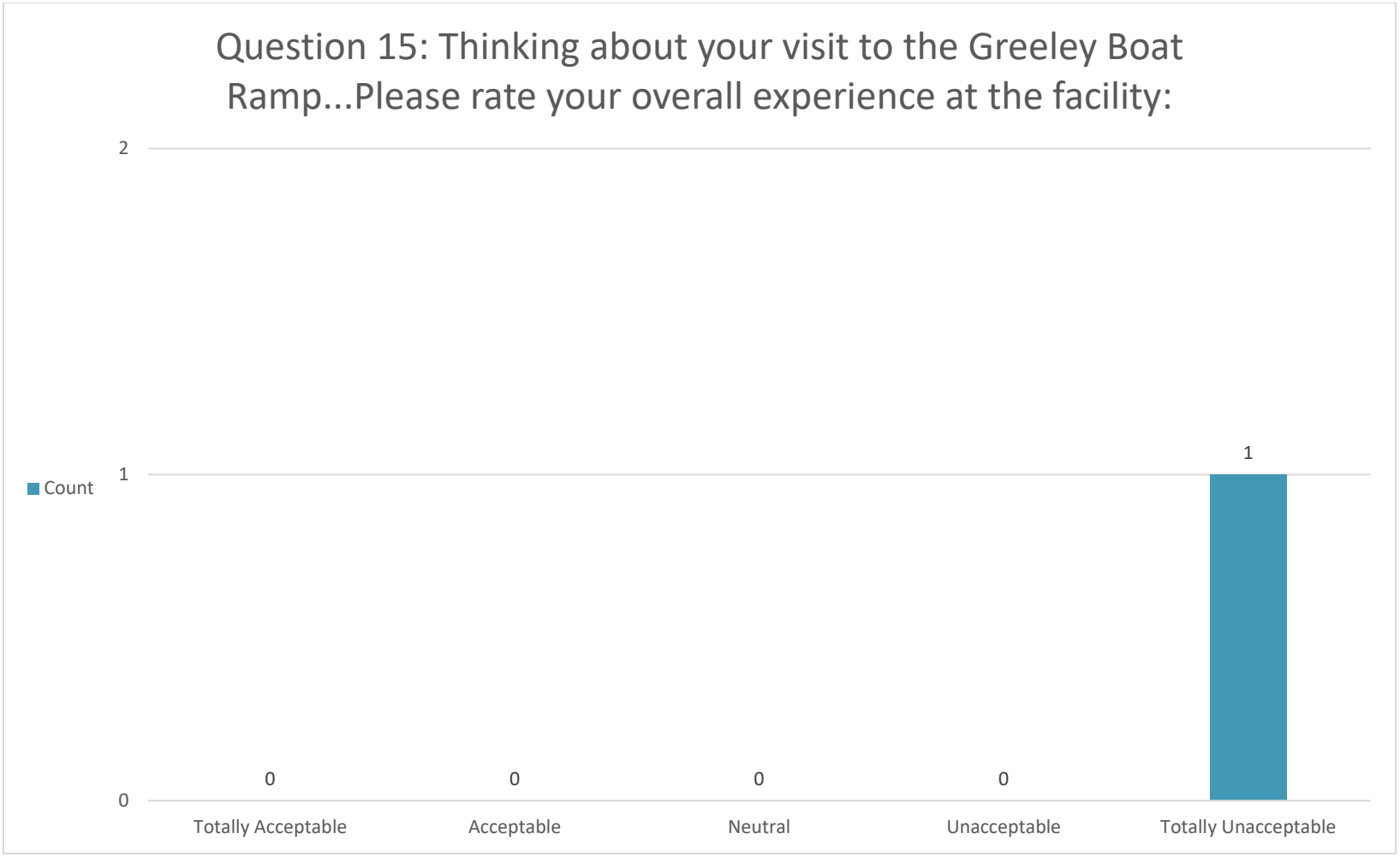

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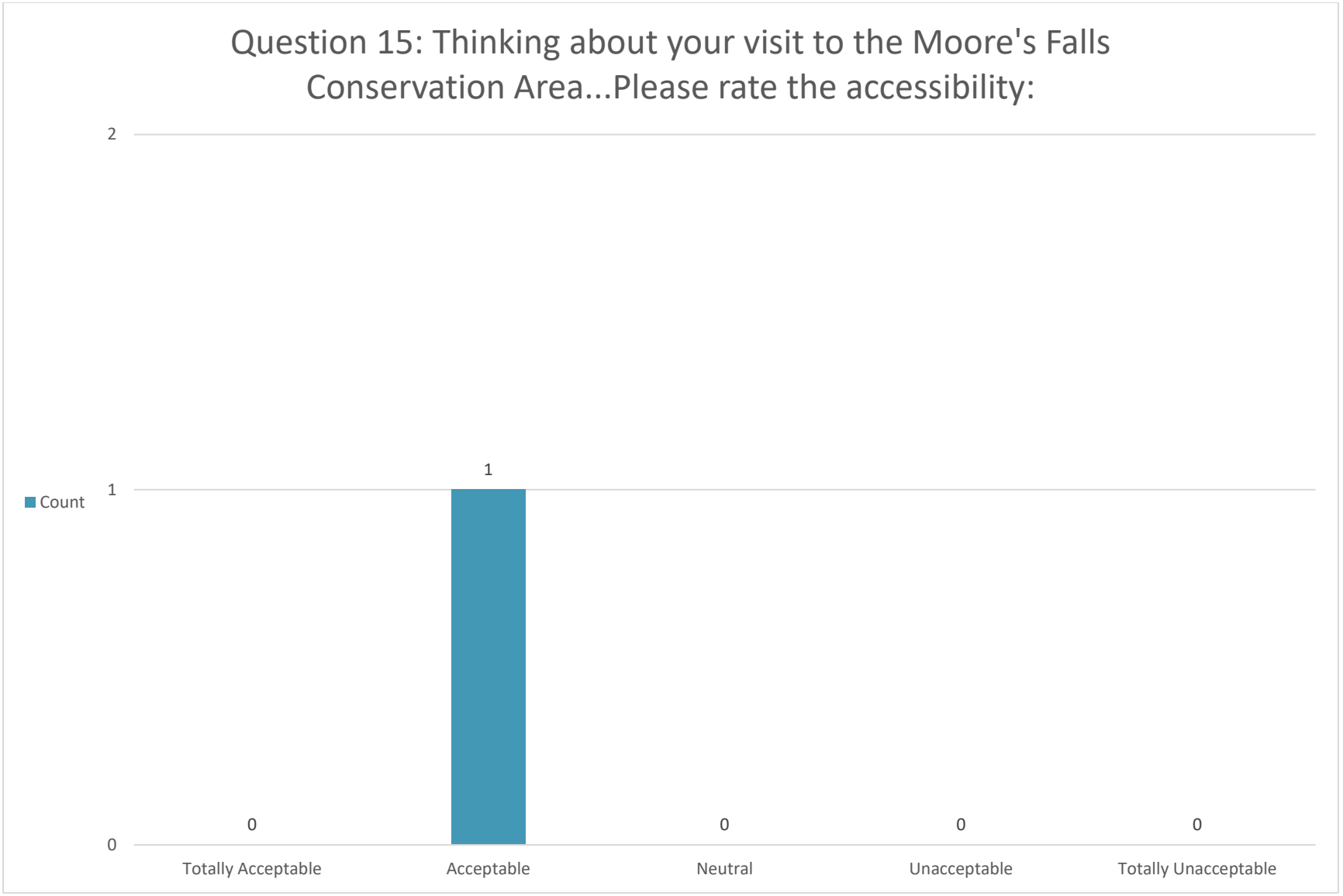

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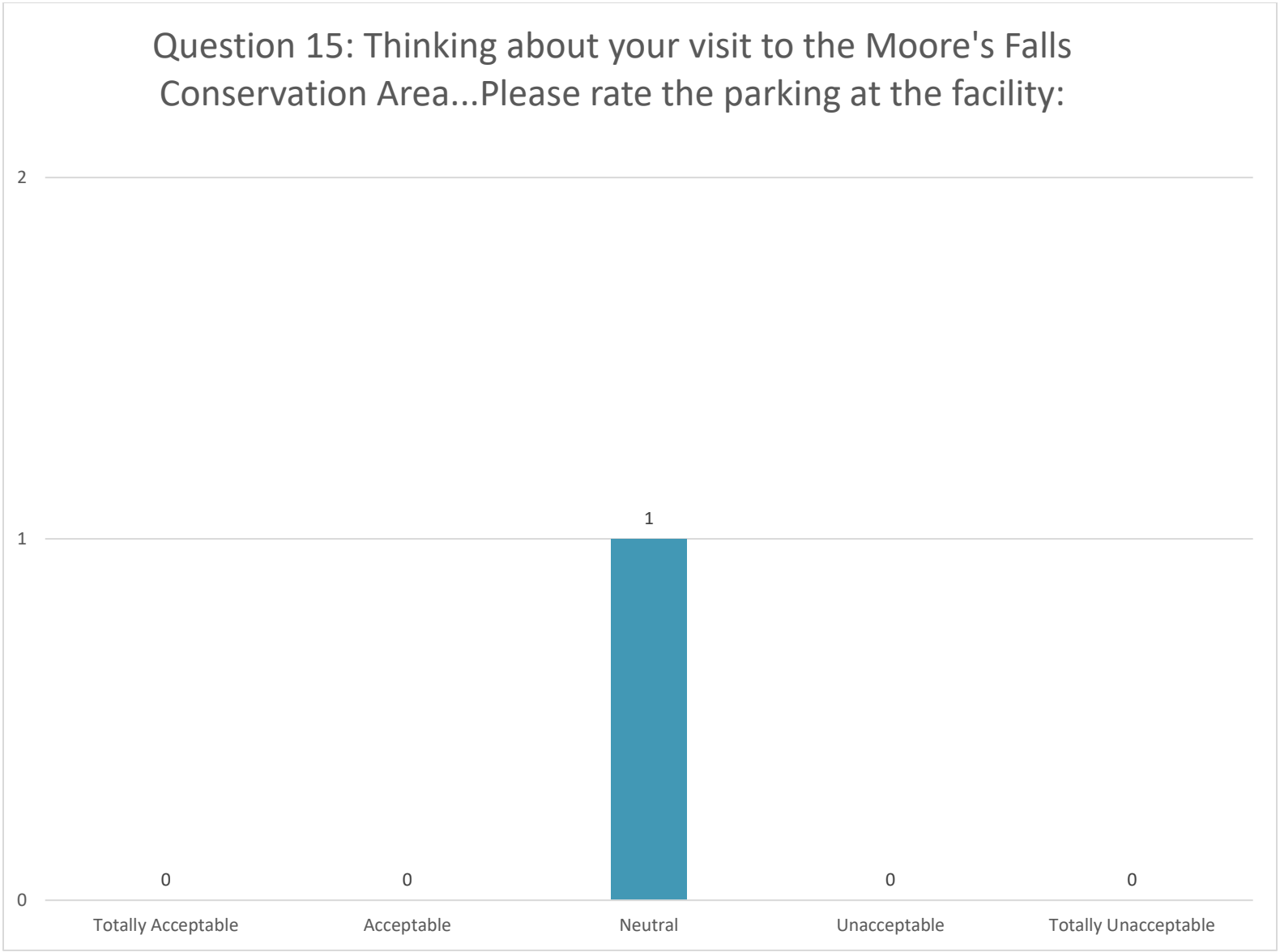
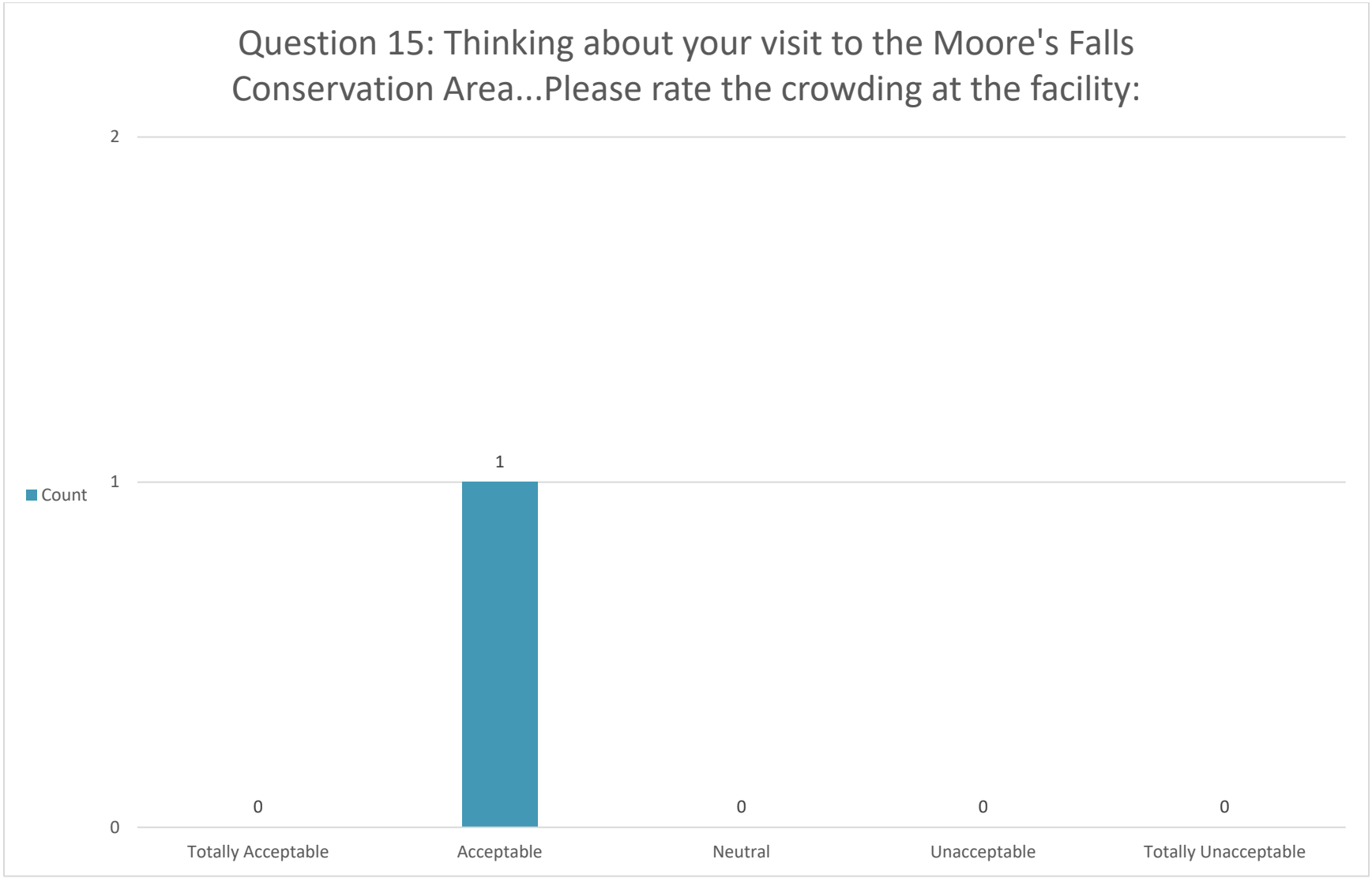


*Percentages not shown for respondent counts under ten.



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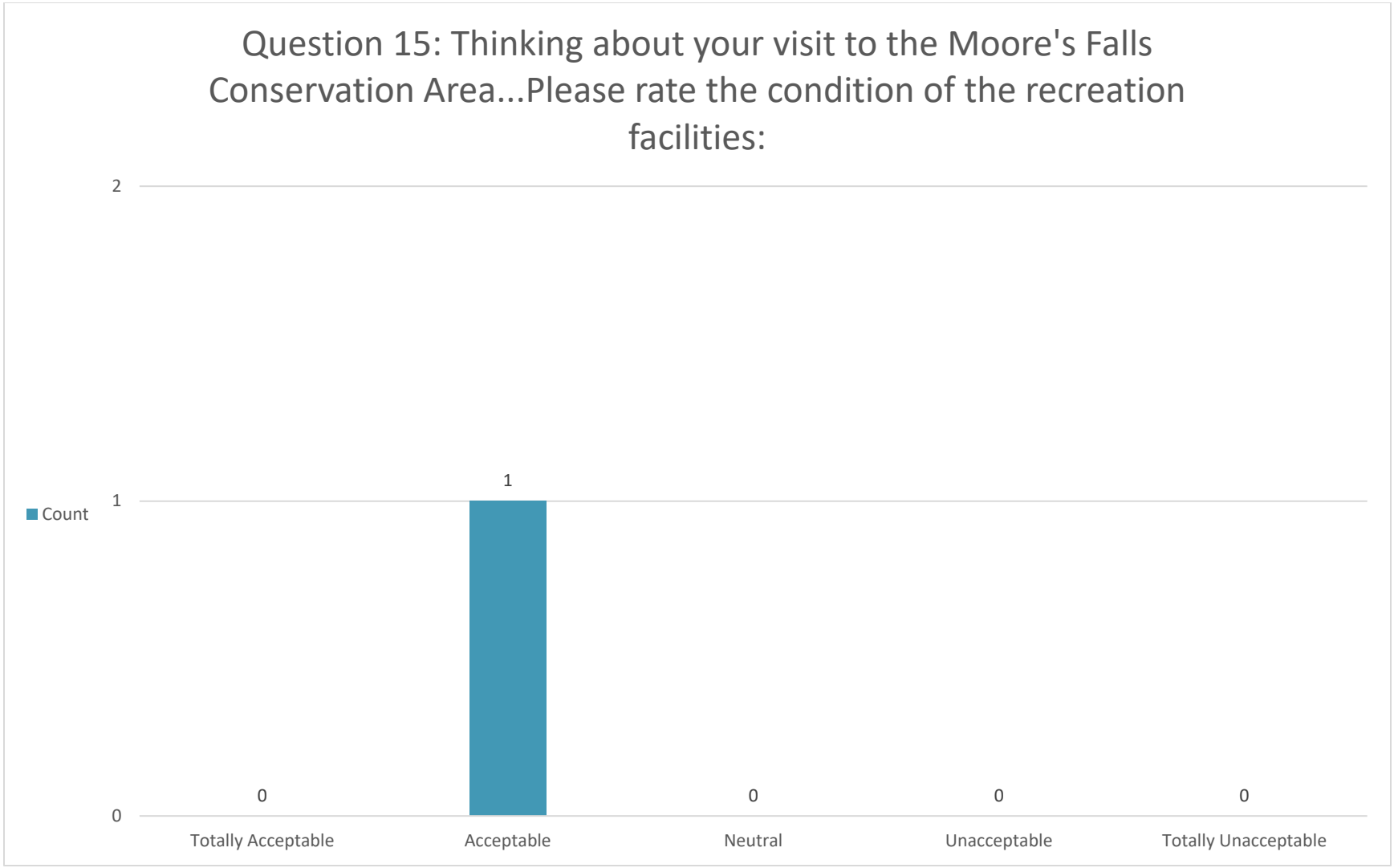

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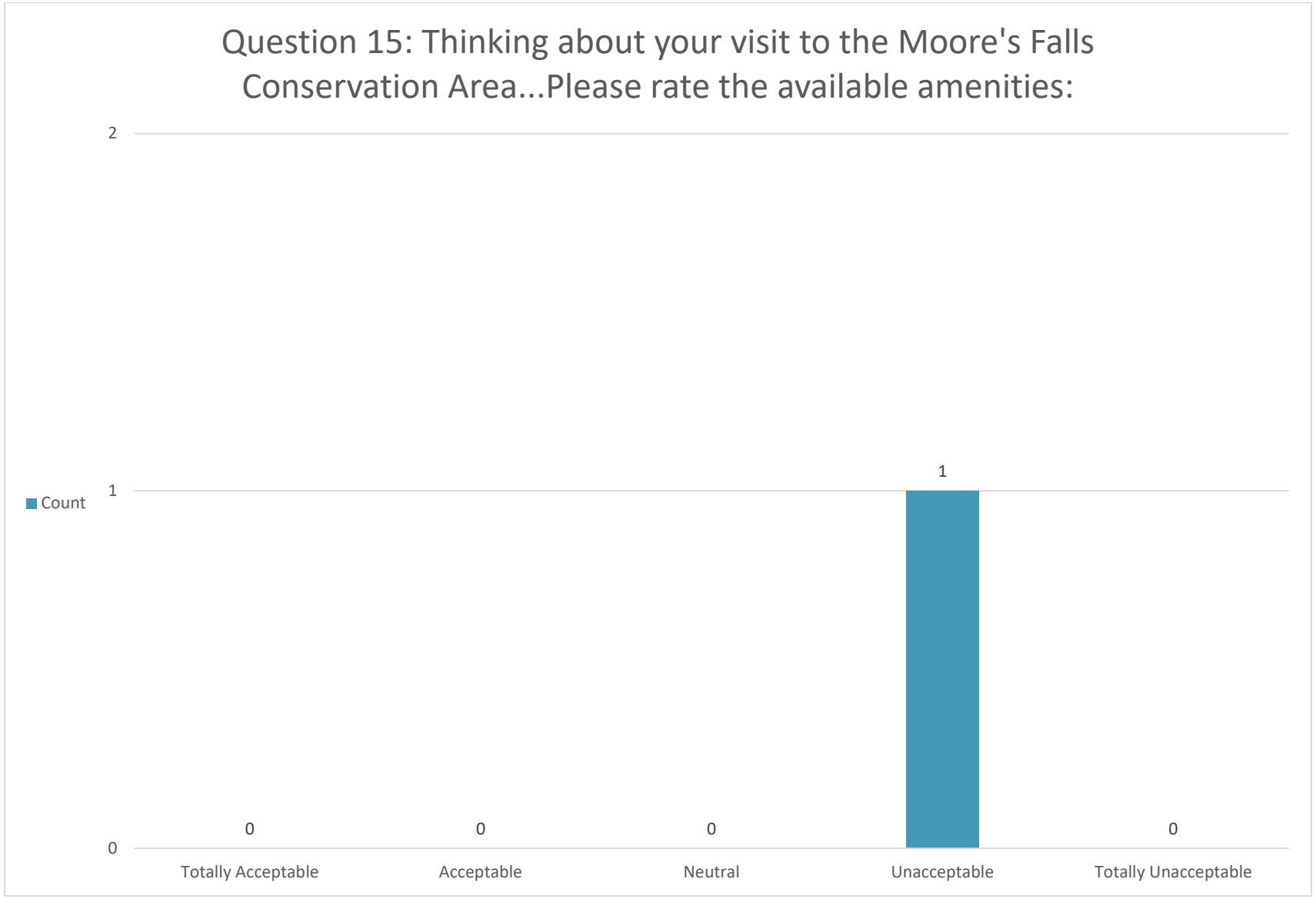

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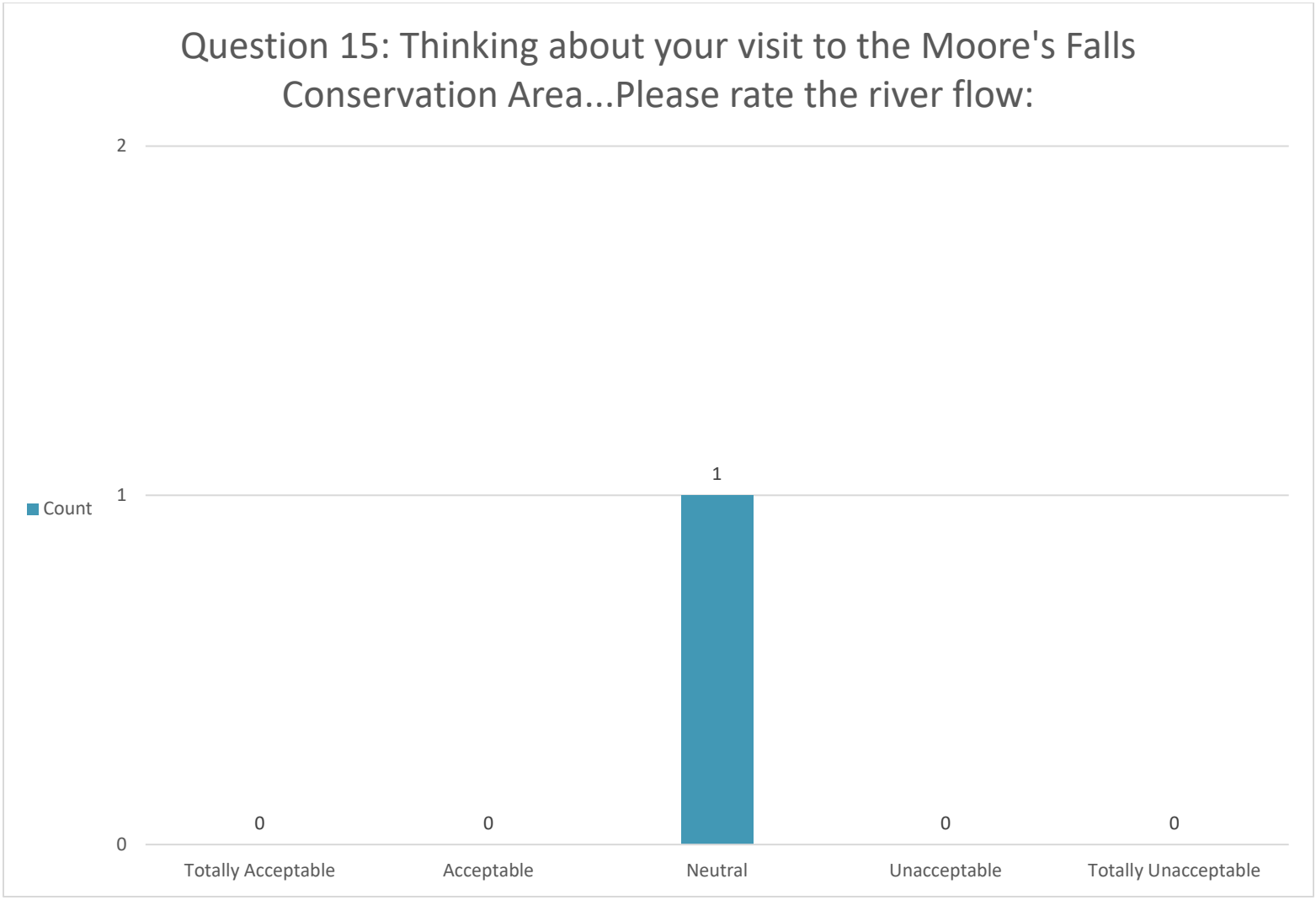
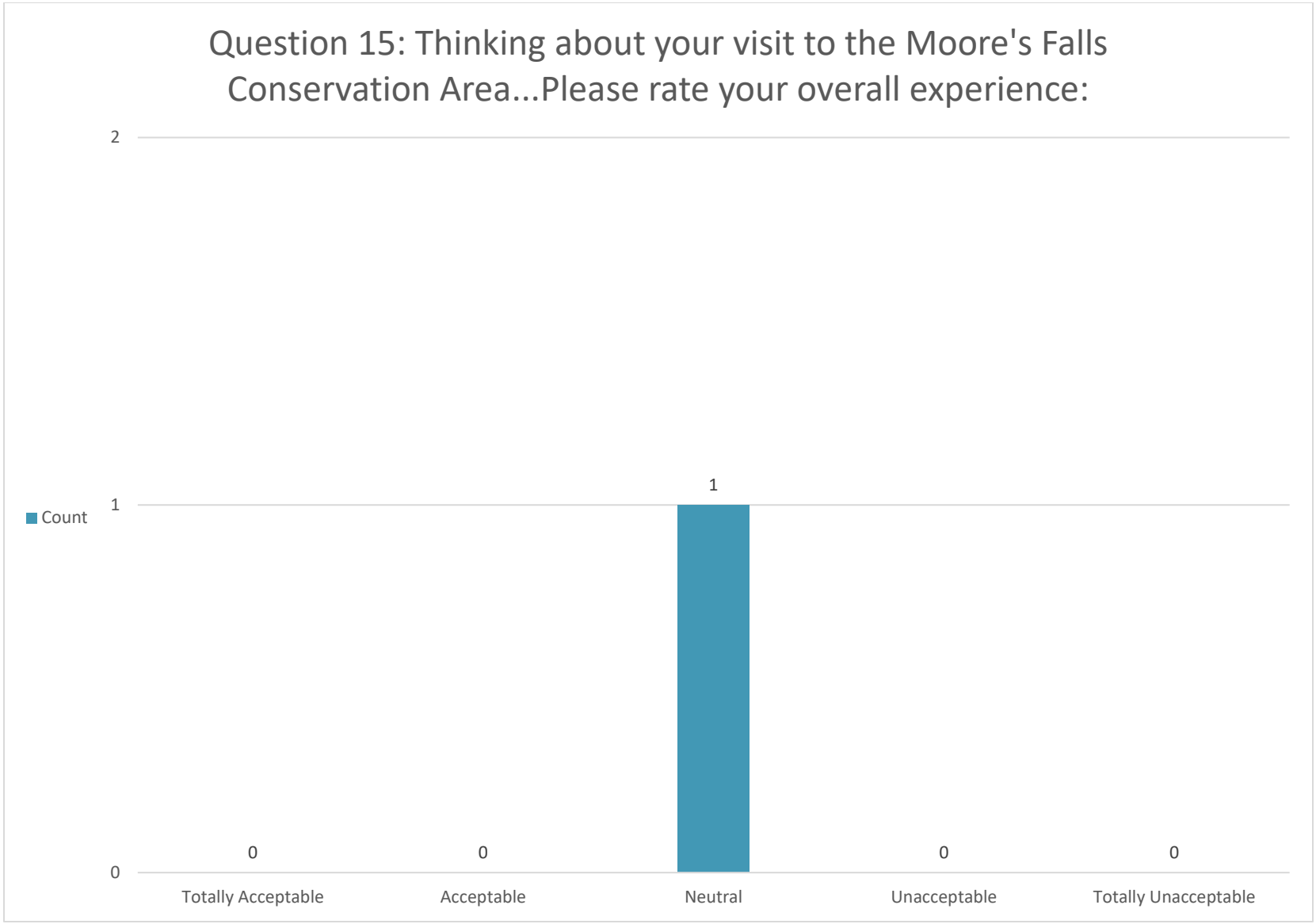


*Percentages not shown for respondent counts under ten.



*Percentages not shown for respondent counts under ten.

	Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 17: Please share any other comments that you have regarding recreation at the Lowell Project:
Recorded Date	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q17. General comments**
5/26/2019 19:18	Bathroom, fix boat ramp	Chelmsford Boat Ramp			
5/26/2019 19:18	Better parking more; more cleanliness	Lowell Heritage State Park	Needs a bathroom	Rourke Brothers Boat Ramp	
5/26/2019 19:18	Bathroom would be nice	Rourke Brothers Boat Ramp			Very clean, Every year is cleaner!
5/26/2019 19:18	Better ramp	Chelmsford Boat Ramp			
5/26/2019 19:18	Fix sidewalks, add grills, add picnic tables	Lowell Heritage State Park			Need professionally experienced oversight of programs that are held here. Hold events on holidays. More park staff for events.
5/26/2019 19:18	Bike and walk lanes	Merrimack River trail	Signage for opening of gates	Northern canal walkway	Nice dam; aesthetically pleasing
5/26/2019 19:18	Dock sanding, longer ramp	Rourke Brothers Boat Ramp	Repave of ramp, dock, trash barrel	Chelmsford	More access on opposite side of river of rourke bros ramp
5/26/2019 19:18	More fishing piers	Rourke Brothers Boat Ramp			
5/26/2019 19:18	New boat launch- deteriorating, public bathroom	Chelmsford Boat Ramp	Bathroom	Rourke ramp; Canal walkways	Flooding upstream with obermeyer; safety with powered crafts- post safety regs
5/27/2019 21:51	When students row rowing they should park on the side of the side of the road				Need bathrooms; trash cans. Two more American Disabilities Act parking at the parking spot. Rowers take all the parking spots.
5/27/2019 21:51	Access to the water	Merrill Park			

	Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 17: Please share any other comments that you have regarding recreation at the Lowell Project:
Recorded Date	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q17. General comments**
5/27/2019 21:51	Porta potty; trail should be widened; some type of advertisement;				
5/27/2019 21:51	Access to the beach and walkway	Chelmsford Boat Ramp			
5/27/2019 21:51	Improve the boat ramp	Chelmsford Boat Ramp			
5/27/2019 21:51	Porta Potty/ bathrooms on site of the boat launch	Chelmsford Boat Ramp			
5/27/2019 21:51					
5/27/2019 21:51	Some access points to the river esp folks want to launch a kayak or canoe	NPS walkway tours			
5/27/2019 21:51	Forest ranger presence	All			Great upkeep of rec facilities
5/27/2019 21:51	Bathroom hours extended until 9pm	Merrimack Trail System			Sometimes the music is too loud.
6/12/2019 7:41					
6/12/2019 7:41					Docks
6/12/2019 7:41					Bathrooms
6/12/2019 7:41					Rope swing to swim.
6/12/2019 7:41					

	Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 17: Please share any other comments that you have regarding recreation at the Lowell Project:
Recorded Date	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q17. General comments**
6/12/2019 7:41	More bathrooms; litter looks bad	Merrimack Trail System			
6/12/2019 7:42					
6/12/2019 7:42					
6/12/2019 7:42					
6/12/2019 7:42	Improve boat ramp and bathroom facilities	Chelmsford Boat Ramp			
6/12/2019 7:42	Trash can	Rourke Brothers Boat Ramp			
6/12/2019 7:42	Rent paddleboards	Chelmsford Boat Ramp			
7/26/2019 19:47	Turning lane into facility	Rourke Brothers Boat Ramp			Considers rourke bros third in the state; really nice
7/26/2019 19:47	Porta potty	Rourke Brothers Boat Ramp			
7/26/2019 19:47	Trash can	Pawtucket Overlook and Canal Walkways			
7/26/2019 19:47	Porta potty and trash can	Chelmsford Boat Ramp			
7/26/2019 19:48					
8/26/2019 10:55					

	Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 17: Please share any other comments that you have regarding recreation at the Lowell Project:
Recorded Date	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q17. General comments**
8/26/2019 10:55					"Informational panels great
8/26/2019 10:55	Paving, add flowering trees, higher barrier	Merrimack Trail System			
8/26/2019 10:55	Clean up trash in canal	Pawtucket Falls Overlook			
8/26/2019 10:55	Lifeguards during summer	Lowell Heritage State Park			
8/26/2019 10:55	Porta potty	Rourke Brothers Boat Ramp			
8/26/2019 10:55	Tray barrel and porta potty	Rourke Brothers Boat Ramp			
10/13/2019 19:46	Update bathrooms				
10/13/2019 19:46	Roads in and out need work and parking	Chelmsford Boat Launch			
10/31/2019 15:17	Blacktop the path occasionally	Merrimack Trail System			Walkway tours = visitor center
10/31/2019 15:17	Maintenance of benches, signs, add signage of existing facilities	Canal Walkway			
10/31/2019 15:17	More tables	Lowell Heritage State Park			
10/31/2019 15:17	Permanent bathroom or porta potty	Rourke Brothers Boat Ramp	Trashcan	Rourke brothers	

	Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 16: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 17: Please share any other comments that you have regarding recreation at the Lowell Project:
Recorded Date	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q16. Type of Recreation Enhancement:**	**Q. 16 Location(s)**	**Q17. General comments**
10/31/2019 15:17	Benches, trash can	Pawtucket Falls Overlook			
10/31/2019 15:17	Numbering of trees for emergency reasons	Lowell Heritage State Park	Volunteer ranger Dogs on leash	Lowell Heritage State Park	Policing good on weekends
10/31/2019 15:17					Trash at dam
10/31/2019 15:17	More benches in some areas; better signage at intersections				Set up volunteer rangers

Appendix D - Field Reconnaissance Data

Field Reconnaissance Data

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
May 25, 2019	Chelmsford Boat Access	Cloudy/partially sunny	8:04 – 9:06	• 3 cars	2	• Hiking • Boating
May 25, 2019	Merrill Park	Cloudy/partially sunny	9:30 – 10:30	• 0	1	• Walking
May 25, 2019	Rourke Brothers Boat Ramp	Cloudy/partially sunny	11:03 – 11:57	• 10 cars • 8 cars with trailers	16	• Boating • Kayaking • Paddle board
May 25, 2019	Merrimack Trail System	Cloudy/partially sunny	12:10 – 1:07	• 0	100	• Boating • Running, jogging, hiking
May 25, 2019	Pawtucket Falls Overlook	Cloudy/partially sunny	1:58 – 2:57	• 0	8	• Boating • Hiking
May 25, 2019	Lowell Heritage State Park	Cloudy/partially sunny	3:14 – 4:11	• Not recorded	150	• Hiking • Running, jogging, and fitness • Dog walking • Boating
May 25, 2019	NPS Canal Walkways	Cloudy/partially sunny	4:50 – 5:50	• N/A	30	• Picnicking
May 26, 2019	Lowell Heritage State Park	Sunny, 70s	8:30 – 9:30	• 30 cars	90	• Boating • Hiking • Bicycling • Picnicking • Running, jogging, and fitness • Dogwalking
May 26, 2019	Pawtucket Falls Overlook	Sunny, 70s	9:41 – 9:45	• 0	4	• Hiking/walking
May 26, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s	10:57 – 12:02	• 20 cars	35	• Park attendance
May 26, 2019	NPS Canal Walkways	Sunny, 70s	12:10 – 13:18	• N/A	40	• Walking

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
May 26, 2019	Chelmsford Boat Access	Sunny, 70s	14:10 – 15:10	• 7 cars • 5 cars with boat trailers		• Boating
May 26, 2019	Merrimack Trail System	Sunny, 70s	17:09 – 18:10	• 60 cars (not including overflow parking)	175	• Hiking/Walking
May 27, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s	8:30 – 9:30	• 0	2	• Park attendance
May 27, 2019	Merrimack Trail System	Sunny, 70s	9:55 – 11:00	• 20 rowing boats	250	• A regatta for the Massachusetts Public Schools Rowing Association • Hiking, walking, bicycling
May 27, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	11:56 – 12:59	• 25 cars • 3 boats • 1 Moped • 1 car trailer	10	• Boating • Dog walking
May 27, 2019	Chelmsford Boat Access	Sunny, 70s	15:38 – 16:42	• 5 jet skis • 7 boat trailers	26	• Boating • Hiking, walking • Dog walking
May 27, 2019	Pawtucket Falls Overlook	Sunny, 70s	16:59 – 18:00	• 0	1	• Hiking/Walking
May 28, 2019	Rourke Brothers Boat Ramp	Overcast, 50s	8:05 – 9:08	• 2 cars	2	• Hiking/walking
May 28, 2019	NPS Canal Walkways	Overcast, 50s	9:20 – 10:30	• 0	14	• Park attendance • Fishing
May 28, 2019	Merrimack Trail System	Overcast, 50s	10:45 – 11:45	• 15 cars	29	• Hiking/walking • Fishing • Running/jogging
May 28, 2019	Lowell Heritage State Park	Overcast, 50s	11:48 – 12:45	• 3	2	• Dog walking • Hiking/walking • Running/Jogging

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
May 28, 2019	Pawtucket Falls Overlook	Overcast, 50s	12:53 – 13:56	• 1 car	1	• Walking
May 28, 2019	Chelmsford Boat Access	Overcast, 50s	14:27 – 15:24	• 1 car	0	• N/A
May 28, 2019	Lowell National Historical Park Visitor Center	Overcast, 50s	17:50 – 18:00	• 0	0	• Park was closed
June, 07, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	8:00 – 9:01	• 2 cars	2	• Bicycling
June, 07, 2019	Merrill Park	Sunny, 80s	9:24 – 10:24	• 0	0	• N/A
June, 07, 2019	Chelmsford Boat Access	Sunny, 80s	10:54 – 12:00	• 4 cars	4	• Boating • Fishing
June, 07, 2019	Lowell National Historical Park Visitor Center	Sunny, 80s	12:15 – 13:18	• 0	36	• Park attendance
June, 07, 2019	NPS Canal Walkways	Sunny, 80s	13:18 – 14:20	• 0	40	• Walking • Bicycling
June, 07, 2019	Pawtucket Falls Overlook	Sunny, 80s	14:20 – 15:20	• 1 cars	2	• Walking
June, 07, 2019	Lowell Heritage State Park	Sunny, 80s	15:29 – 16:30	• 5 cars	40	• Hiking/walking • Picnicking • Bicycling • Boating
June, 07, 2019	Merrimack Trail System	Sunny, 80s	16:30 – 17:30	• 35 cars	60	• Hiking/walking • Picnicking • Boating • Fishing • Skateboarding • Paddle boarding
June, 07, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	17:40 – 18:00	• 9 cars	10	• Boating • Walking

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
June 10, 2019	Merrimack Trail System	Sunny, 80s	8:08 – 9:08	• 30 cars	40	• Fishing • Running/jogging • Hiking/walking
June 10, 2019	Lowell Heritage State Park	Sunny, 80s	9:08 – 10:06	• 40 cars	60	• Running/jogging • Hiking/walking • Bicycling
June 10, 2019	Pawtucket Falls Overlook	Sunny, 80s	10:19 – 11:17	• 4 cars	2	• Walking
June 10, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	11:28 – 12:26	• 13 cars	12	• Boating
June 10, 2019	Merrill Park	Sunny, 80s	13:15 – 14:13	• 0 cars	2	• Boating • Bicycling
June 10, 2019	Chelmsford Boat Access	Sunny, 80s	14:45 – 15:53	• 5 cars	8	• Boating • Fishing
June 10, 2019	Lowell National Historical Park Visitor Center	Sunny, 80s	16:10 – 17:09	• 0 cars	8	• Park attendance
June 10, 2019	NPS Canal Walkways	Sunny, 80s	17:09 – 18:09	• 0 cars	20	• Hiking/walking • Fishing
June 15, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	8:00 – 9:00	• 3 cars	3	• Boating
June 15, 2019	Merrill Park	Sunny, 70s	9:25 – 10:25	• 0	2	• Bicycling
June 15, 2019	Chelmsford Boat Access	Sunny, 70s	11:10 – 12:13	• 1 boat trailer	5	• Boating • Fishing • Softball tournament
June 15, 2019	NPS Canal Walkways	Sunny, 70s	13:10 – 14:10	• 0	15	• Hiking/walking • Picnicking
June 15, 2019	Pawtucket Falls Overlook	Sunny, 70s	14:32 – 15:35	• 0	3	• Hiking/walking
June 15, 2019	Merrimack Trail System	Sunny, 70s	15:47 – 16:48	• 100	100	• Hiking/walking • Bicycling • Picnicking • Fishing • Boating • Running

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
June 15, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	17:00 – 18:00	• 14 cars	30	• Boating • Jet skiing • Dog walking
June 16, 2019	Rourke Brothers Boat Ramp	Rainy, 60s	8:00 – 9:03	• 1 boat trailer • 1 car	1	• Dog walker
June 16, 2019	Lowell Heritage State Park	Rainy, 60s	9:23 – 10:23	• 8 cars	55	• Running/jogging • Hiking/walking • Bicycling • Picnicking
June 16, 2019	Lowell National Historical Park Visitor Center	Rainy, 60s	10:30 – 11:30	• 0	7	• Hiking/walking
June 16, 2019	NPS Canal Walking	Rainy, 60s	11:37 – 12:37	• 0	4	• Walking
June 16, 2019	Merrill Park	Rainy, 60s	13:21 – 14:28	• 1 car	2	• Dog walking
June 16, 2019	Chelmsford Boat Access	Rainy, 60s	15:10 – 16:10	• N/A	N/A	• N/A
June 16, 2019	Pawtucket Falls Overlook	Rainy, 60s	16:21 – 17:21	• 0	2	• Walking • Dog walking
June 16, 2019	Merrimack Trail System	Rainy, 60s	17:25 – 18:00	• 8	10	• Sitting in cars (raining) • Walking
July 10, 2019	Merrimack Trail System	Cloudy and Sunny, 60s	8:15 – 9:15	• 7 cars	8	• Hiking/walking
July 10, 2019	Merrill Park	Cloudy and Sunny, 60s	9:55 – 10:55	• 0	0	• N/A
July 10, 2019	Chelmsford Boat Access	Cloudy and Sunny, 60s	11:25 – 12:25	• 3 cars	5	• N/A
July 10, 2019	Pawtucket Falls Overlook	Cloudy and Sunny, 60s	13:15 – 14:15	• 0	0	• N/A
July 10, 2019	NPS Canal Walkways	Cloudy and Sunny, 60s	14:40 – 15:40	• 5	50	• Hiking/Walking • Bicycling • Swimming
July 10, 2019	Whitewater takeout	Cloudy and Sunny, 60s	15:52 – 16:50	• 0	0	• N/A
July 10, 2019	Rourke Brothers Boat Ramp	Cloudy and Sunny, 60s	16:50 – 18:00	• 8 cars	7	• Boating

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
July 19, 2019	Rourke Brothers Boat Ramp	Overcast, 70s	8:00 – 9:00	• 5 cars	2	• Dog walking • Bicycling • Fishing
July 19, 2019	Pawtucket Falls Overlook	Overcast, 70s	9:35 – 10:44	• 0	0	• N/A
July 19, 2019	Lowell National Historical Park Visitor Center	Overcast, 70s	10:58 – 11:58	• 0	9	• N/A
July 19, 2019	NPS Canal Walkways	Overcast, 70s	12:24 – 13:20	• 0	10	• N/A
July 19, 2019	Merrimack Trail System	Overcast, 70s	13:38 – 14:42	• 20 cars	50	• Boating • Running/jogging • Hiking/walking • Bicycling • Dog walking
July 19, 2019	Merrill Park	Overcast, 70s	15:25 – 16:25	• 1 car	8	• Bicycling
July 19, 2019	Whitewater Takeout	Overcast, 70s	17:00 – 18:00	• 0	0	• N/A
July 27, 2019	Merrimack Trail System	Sunny, 80s	8:07 – 9:06	• 40 cars	80	• Dog walker • Picnicking • Bicycling • Hiking/walking • Running/jogging
July 27, 2019	Merrill Park	Sunny, 80s	9:45 – 10:45	• 1	2	• Dog walker • Jet ski
July 27, 2019	Chelmsford Boat Access	Sunny, 80s	11:06 –12:07	• 2 cars • 4 boat trailers	10	• Picnicking • Boating • Softball tournaments
July 27, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	12:19 – 13:20	• 20 cars	15	• Boating • Fishing • Bicycling • Picnicking
July 27, 2019	Pawtucket Falls Overlook	Sunny, 80s	14:02 – 15:02	• 0	0	• N/A
July 27, 2019	Whitewater Takeout	Sunny, 80s	15:10 – 16:10	• 0	0	• N/A
July 27, 2019	Lowell Heritage State Park	Sunny, 80s	16:20 – 17:20	• 30 cars	70	• Boating

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
						• Picnicking • Hiking/walking • Dog walking • Swimming
July 27, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	18:00 – 19:00	• 14 cars • 6 trailers • 3 boaters	3	• Boating • Walking
July 28, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s	8:30 – 9:30	• 0	7	• Park attendance
July 28, 2019	NPS Canal Walkways	Sunny, 70s	9:35 – 10:35	• 0	10	• Walking
July 28, 2019	Pawtucket Falls Overlook	Sunny, 70s	10:52 – 11:52	• 0	0	• N/A
July 28, 2019	Chelmsford Boat Access	Sunny, 70s	12:10 – 13:10	• 5 boat trailers	10	• Running/hiking • Boating • Bicycling
July 28, 2019	Merrill Park	Sunny, 70s	13:45 – 14:45	• 0	3	• Boating (not at Merrill Park, but observed from Merrill Park) • Fishing
July 28, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	15:05 – 16:05	• 15 boat trailers	23	• Boating • Bicycling • Sailboating • Jet skiing
July 28, 2019	Lowell Heritage State Park	Sunny, 70s	16:25 – 17:25	• 35 cars	100	• Swimming • Running/jogging • Hiking/walking • Picnicking • Bicycling • Skateboarding • Dog walking
August 6, 2019	Merrimack Trail System	Sunny, 80s	8:10 – 9:10	• 50 cars	70	• Boating • Fishing • Running/jogging • Hiking/walking • Bicycling • Picnicking

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
						• Dog walking
August 6, 2019	Merrill Park	Sunny, 80s	09:45 – 10:45	• 0	0	• N/A
August 6, 2019	Chelmsford Boat Access	Sunny, 80s	11:20 – 12:20	• 3 cars	3	• Picnicking
August 6, 2019	Pawtucket Falls Overlook	Sunny, 80s	13:15 – 14:15	• 0	4	• Hiking/walking
August 6, 2019	Rourke Brothers Boat Ramp	Sunny, 80s	14:31 – 15:32	• 7 cars • 2 boat trailers	5	• Jet ski • Boating • Bicycling
August 6, 2019	Lowell Heritage State Park	Sunny, 80s	16:00 – 17:00	• 20 cars	60	• Picnicking • Swimming
August 6, 2019	Lowell National Historical Park Visitor Center	Sunny, 80s	17:21 – 18:00	• 0	11	• Park attendance
August 18, 2019	Lowell Heritage State Park	Cloudy, 80s	8:07 – 9:07	• 20 cars	90	• Running/jogging • Hiking/walking • Picnicking • Boating • Dog walkers
August 18, 2019	Chelmsford Boat Access	Cloudy, 80s	9:20 – 10:30	• 1 car • 1 trailer	4	• Softball tournament • Boating
August 18, 2019	Merrill Park	Cloudy, 80s	11:10 – 12:10	• 1 car	2	• Picnicking
August 18, 2019	Merrimack Trail System	Cloudy, 80s	12:45 – 13:45	• 50 cars	125	• Running/jogging • Hiking/walking • Bicycling
August 18, 2019	Lowell National Historical Park Visitor Center	Cloudy, 80s	14:35 – 15:35	• 0	21	• Park attendance
August 18, 2019	Pawtucket Falls Overlook	Cloudy, 80s	15:56 – 16:56	• 0	2	• Hiking/walking
August 18, 2019	Rourke Brothers Boat Ramp	Cloudy, 80s	17:09 – 18:00	• 11 cars • 8 boat trailers	14	• Boating • Fishing
August 21, 2019	Lowell Heritage State Park	Overcast, Rainy, 70s	8:00 – 9:00	• 15 cars	55	• Running/jogging • Hiking/walking • Dog walking
August 21, 2019	NPS Canal Walkways	Overcast, Rainy, 70s	9:15 – 10:15	• 0	30	• Walking • Dog walking

Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
						• Picnicking
August 21, 2019	Merrill Park	Overcast, Rainy, 70s	10:55 – 11:55	• 0	0	• N/A
August 21, 2019	Pawtucket Falls Overlook	Overcast, Rainy, 70s	12:30 – 13:30	• 0	2	• Dog walking
August 21, 2019	Rourke Brothers Boat Ramp	Overcast, Rainy, 70s	14:20 – 15:20	• 6 cars • 2 boat trailers	0	• Boating
August 21, 2019	Chelmsford Boat Access	Overcast, Rainy, 70s	15:30 – 16:30	• 0	0	• N/A
August 21, 2019	Merrimack Trail System	Overcast, Rainy, 70s	16:50 – 17:50	• 15 cars	40	• Running/jogging • Hiking/walking • Bicycling • Dog walking
August 24, 2019	Pawtucket Falls Overlook	Sunny, 70s	9:30 – 10:30	• 0	0	• N/A
August 24, 2019	Merrill Park	Sunny, 70s	11:20 – 12:20	• 0	0	• N/A
August 24, 2019	Chelmsford Boat Access	Sunny, 70s	12:45 – 13:45	• 10 cars • 6 trailers	18	• Boating • Bicycling
August 24, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s	14:45 – 15:45	• 0	49	• Park attendance
August 24, 2019	NPS Canal Walkways	Sunny, 70s	16:00 – 17:00	• 0	12	• Walking • Picnicking
August 24, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	17:15 – 18:00	• 4 cars • 5 trailers	8	• Boating • Fishing • Bicycling
September 14, 2019	Rourke Brothers Boat Ramp	Cloudy, rainy, 60s	8:15 – 9:15	• 2 cars	2	• Walking
September 14, 2019	Pawtucket Falls Overlook	Cloudy, rainy, 60s	9:25 –10:25	• 0	0	• N/A
September 14, 2019	Merrill Park	Cloudy, rainy, 60s	11:02–12:05	• 3 cars	3	• Picnicking
September 14, 2019	Chelmsford Boat Access	Cloudy, rainy, 60s	12:35 –13:35	• 0	2	• Fishing • Softball tournament
September 14, 2019	NPS Canal Walkways	Cloudy, rainy, 60s	14:45 – 15:45	• 0	1	• Running/jogging
September 14, 2019	Lowell Heritage State Park	Cloudy, rainy, 60s	16:08 – 17:08	• 2 cars	23	• Hiking/walking
September 14, 2019	Merrimack Trail System	Cloudy, rainy, 60s	17:18 – 18:00	• 10 cars	7	• Hiking/walking

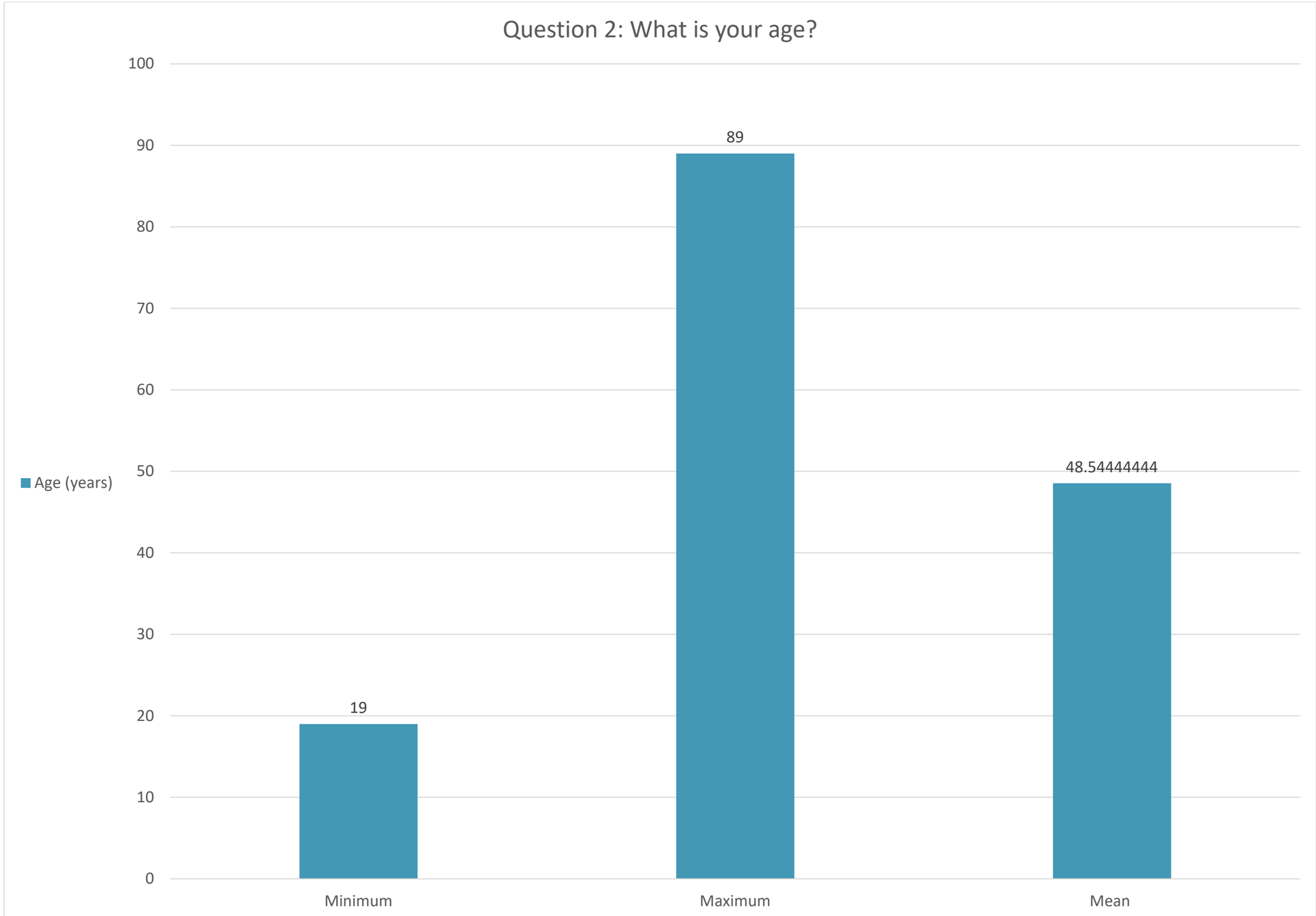
Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
September 19, 2019	Merrimack Trail System	Sunny, cool, 60s	8:00 – 9:00	• 0	54	• Fishing • Running/jogging • Hiking/walking
September 19, 2019	Rourke Brothers Boat Ramp	Sunny, cool, 60s	9:00 – 10:00	• 5 cars • 2 boat trailers	6	• Boating • Fishing
September 19, 2019	Merrill Park	Sunny, cool, 60s	10:30 – 11:30	• 1	2	• Hiking/walking
September 19, 2019	Chelmsford Boat Access	Sunny, cool, 60s	12:00 – 13:00	• 5 cars	1	• Picnicking • Fishing
September 19, 2019	Lowell National Historical Park Visitor Center	Sunny, cool, 60s	13:20 – 14:20	• 0	17	• Park attendance
September 19, 2019	Pawtucket Falls Overlook	Sunny, cool, 60s	15:05 – 16:05	• 0	0	• N/A
September 19, 2019	Lowell Heritage State Park	Sunny, cool, 60s	16:24 – 17:24	• Not Recorded	50	• Hiking/walking • Running/jogging • Bicycling
September 19, 2019	Rourke Brothers Boat Ramp	Sunny, cool, 60s	17:30 – 18:00	• 4 cars • 2 boat trailers	3	• Fishing • Boating
September 22, 2019	Rourke Brothers Boat Ramp	Sunny, 70s – 80s	8:00 – 9:00	• 3 cars • 4 boat trailers	5	• Boating • Fishing
September 22, 2019	Pawtucket Falls Overlook	Sunny, 70s – 80s	9:30 – 10:30	• 0	0	• N/A
September 22, 2019	Merrill Park	Sunny, 70s – 80s	11:00 – 12:00	• 2 trucks	4	• Hiking/walking
September 22, 2019	Chelmsford Boat Access	Sunny, 70s – 80s	12:25 – 13:25	• 6 cars • 5 boat trailers	8	• Boating
September 22, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s – 80s	13:40 – 14:40	• 0	20	• Park attendance • Power outage occurred
September 22, 2019	NPS Canal Walkways	Sunny, 70s – 80s	15:00 – 16:00	• 0	13	• Hiking/walking • Running/jogging • Bicycling
September 22, 2019	Lowell Heritage State Park	Sunny, 70s – 80s	16:10 – 17:10	• 15 cars • 1 boat docked	70	• Swimming • Running/jogging • Hiking/walking • Bicycling • Dog walking
September 22, 2019	Merrimack Trail System	Sunny, 70s – 80s	17:17 – 18:00	• Not recorded	30	• Fishing • Running/jogging

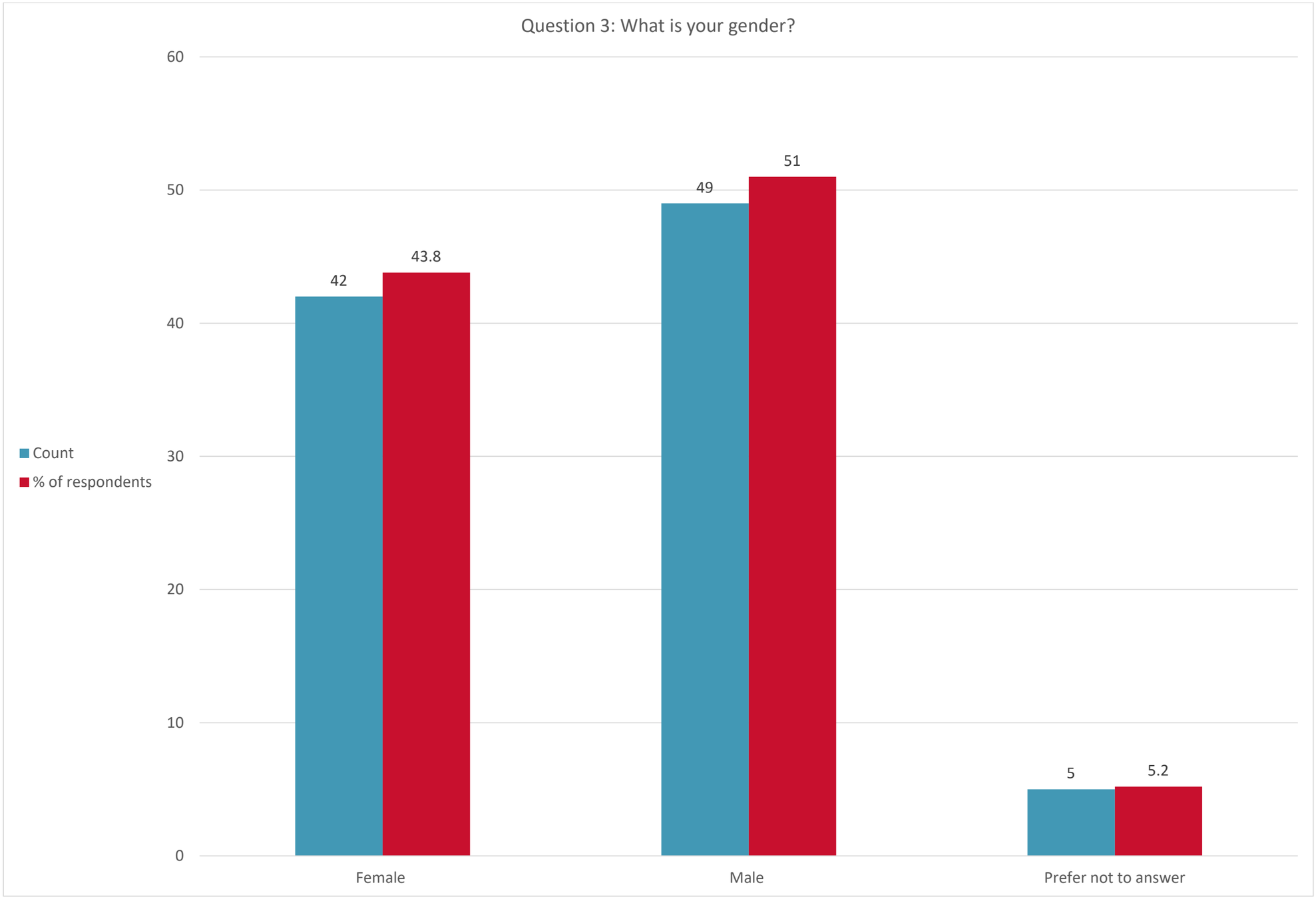
Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
						• Hiking/walking • Bicycling
September 25, 2019	Merrill Park	Sunny, 70s	8:40 – 9:40	• 1 car	1	• Hiking/walking
September 25, 2019	Lowell Heritage State Park	Sunny, 70s	10:20 – 11:20	• Not recorded	60	• Running/jogging • Hiking/walking • Bicycling
September 25, 2019	Pawtucket Falls Overlook	Sunny, 70s	11:25 – 12:25	• 3 cars	0	• N/A
September 25, 2019	Lowell National Historical Park Visitor Center	Sunny, 70s	13:10 – 14:10	• 0	10	• Park attendance
September 25, 2019	NPS Canal Walkways	Sunny, 70s	14:30 – 15:45	• 0	60	• Hiking/walking
September 25, 2019	Rourke Brothers Boat Ramp	Sunny, 70s	16:20 – 17:20	• 4 cars	4	• N/A
September 25, 2019	Merrimack Trail System	Sunny, 70s	17:23 – 18:00	• 45 cars	50	• Fishing • Running/jogging • Hiking/walking
October 9, 2019	Lowell Heritage State Park	Cloudy, windy, 50s	8:20 – 9:20	• 15 cars	19	• Hiking/walking • Running/jogging • Dog walking
October 9, 2019	Rourke Brothers Boat Ramp	Cloudy, windy, 50s	9:30 – 10:30	• 3 cars	1	• Dog walking
October 9, 2019	Merrill Park	Cloudy, windy, 50s	11:09 – 12:09	• 0	0	• N/A
October 9, 2019	NPS Canal Walkways	Cloudy, windy, 50s	12:59 – 13:59	• 0	13	• Hiking/walking
October 9, 2019	Chelmsford Boat Access	Cloudy, windy, 50s	14:46 – 15: 46	• 2 cars	1	• Hiking/walking
October 9, 2019	Pawtucket Falls Overlook	Cloudy, windy, 50s	16:03 – 17:00	• 0	0	• N/A
October 9, 2019	Merrimack Trail System	Cloudy, windy, 50s	17: 11 – 18:00	• 20 cars • 3 boats	32	• Hiking/walking • Running/Jogging • Boating
October 15, 2019	Merrill Park	Sunny, cool, 40-50s	8:10 – 9:10	• 0	0	• N/A
October 15, 2019	Lowell Heritage State Park	Sunny, cool, 40-50s	9:35 – 10:35	• 2 cars	40	• Running/jogging • Hiking/walking • Bicycling
October 15, 2019	Pawtucket Falls Overlook	Sunny, cool, 40-50s	10:40 –11:40	• 0	0	• N/A

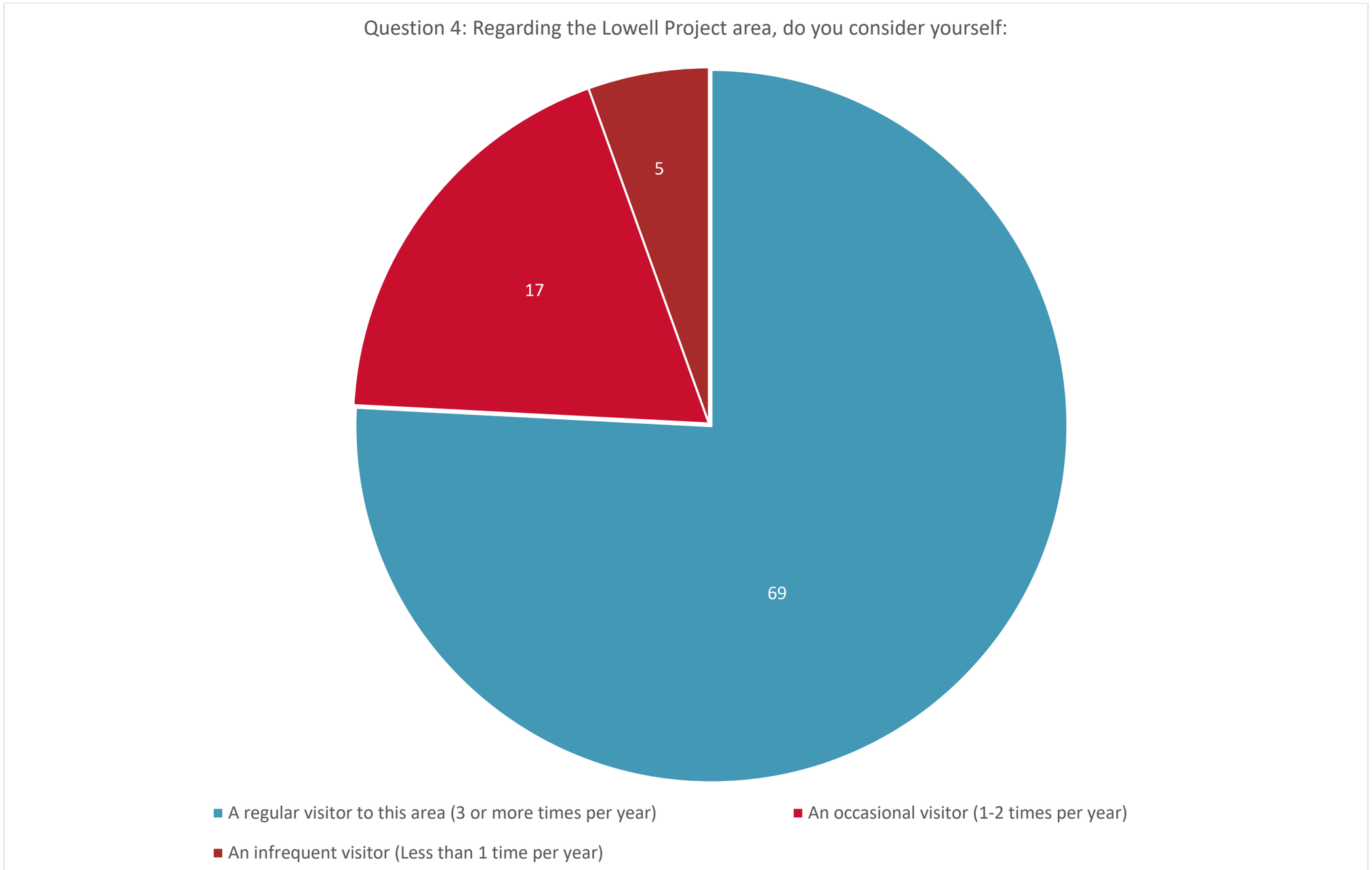
Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
October 15, 2019	Lowell National Historical Park Visitor Center	Sunny, cool, 40-50s	11:49 – 12:49	• 0	32	• Park attendance
October 15, 2019	NPS Canal Walkways	Sunny, cool, 40-50s	12:49 – 13:49	• 0	35	• Hiking/walking
October 15, 2019	Chelmsford Boat Access	Sunny, cool, 40-50s	14:39 – 15:39	• 3 cars	3	• Boating
October 15, 2019	Rourke Brothers Boat Ramp	Sunny, cool, 40-50s	15:50 – 16:50	• 6 cars	6	• Walking/hiking • Boating
October 15, 2019	Merrimack Trail System	Sunny, cool, 40-50s	16:53 – 17:53	• 0	65	• Running/jogging • Hiking/walking • Bicycling • Fishing • Picnicking
October 19, 2019	Rourke Brothers Boat Ramp	Sunny, 40-50s	8:00 – 9:00	• 8 cars	8	• Not recorded
October 19, 2019	Chelmsford Boat Access	Sunny, 40-50s	9:07 – 10:07	• 2 cars	4	• Hiking/walking
October 19, 2019	Merrill Park	Sunny, 40-50s	10:26 – 11:26	• 1 car	3	• Hiking/walking • Fishing
October 19, 2019	Merrimack Trail System	Sunny, 40-50s	11:49 – 12:49	• 0	64	• Running/jogging • Hiking/walking
October 19, 2019	Lowell National Historical Park Visitor Center	Sunny, 40-50s	13:23 – 14:23	• 0	47	• Park attendance
October 19, 2019	Pawtucket Falls Overlook	Sunny, 40-50s	14:32 – 15:32	• 0	2	• Fishing
October 19, 2019	NPS Canal Walkways	Sunny, 40-50s	15:35 –16:35	• 0	58	• Bicycling • Hiking/walking
October 19, 2019	Lowell Heritage State Park	Sunny, 40-50s	16:48 – 17:58	• 0	75	• Running/jogging • Hiking/walking • Bicycling • Picnicking • Boating
October 27, 2019	Pawtucket Falls Overlook	Rainy, cloudy, 50s	8:21 – 9:21	• 0		• Hiking/walking
October 27, 2019	Merrill Park	Rainy, cloudy, 50s	9:49 – 10:49	• 1 car		• Hiking/walking
October 27, 2019	Chelmsford Boat Access	Rainy, cloudy, 50s	11:27 – 12:17	• 1 car		• Boating

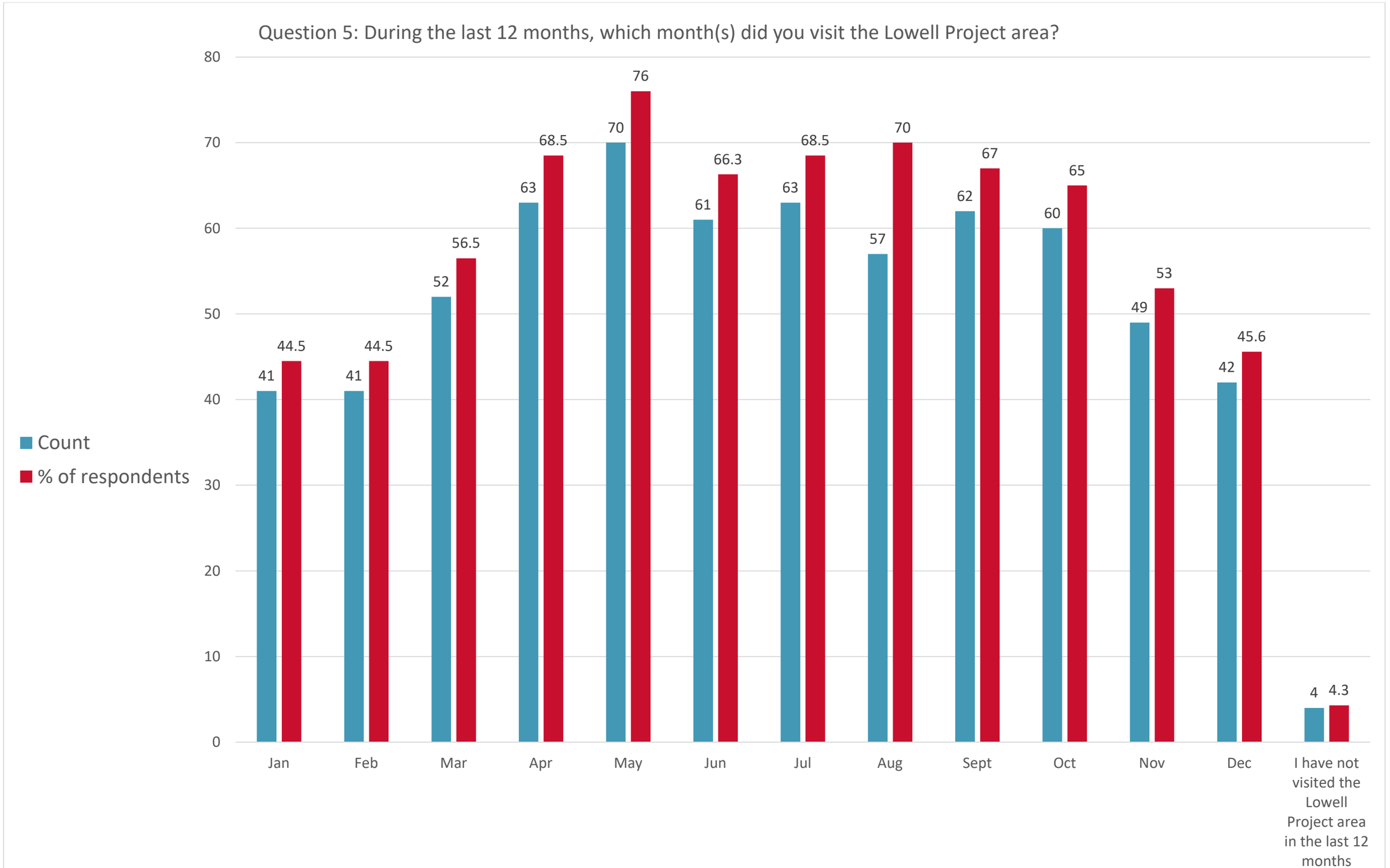
Personal Interviews and Field Reconnaissance Date	Location	Weather Conditions	Time (Military)	Approximate Vehicles Observed	Estimated Number of Recreationists Observed	Observed Recreational Activities
October 27, 2019	Lowell National Historical Park Visitor Center	Rainy, cloudy, 50s	12:31 – 13:31	• 0	13	• Park attendance
October 27, 2019	NPS Canal Walkways	Rainy, cloudy, 50s	14:03 – 15:03	• 0		• Hiking/walking
October 27, 2019	Rourke Brothers Boat Ramp	Rainy, cloudy, 50s	15:20 – 16:20	• 0	0	• N/A
October 27, 2019	Merrimack Trail System	Rainy, cloudy, 50s	16:30 – 17:30	• 4 cars	2	• Hiking/walking
October 27, 2019	Lowell Heritage State Park	Rainy, cloudy, 50s	17:32 – 18:00	• 0	0	• N/A

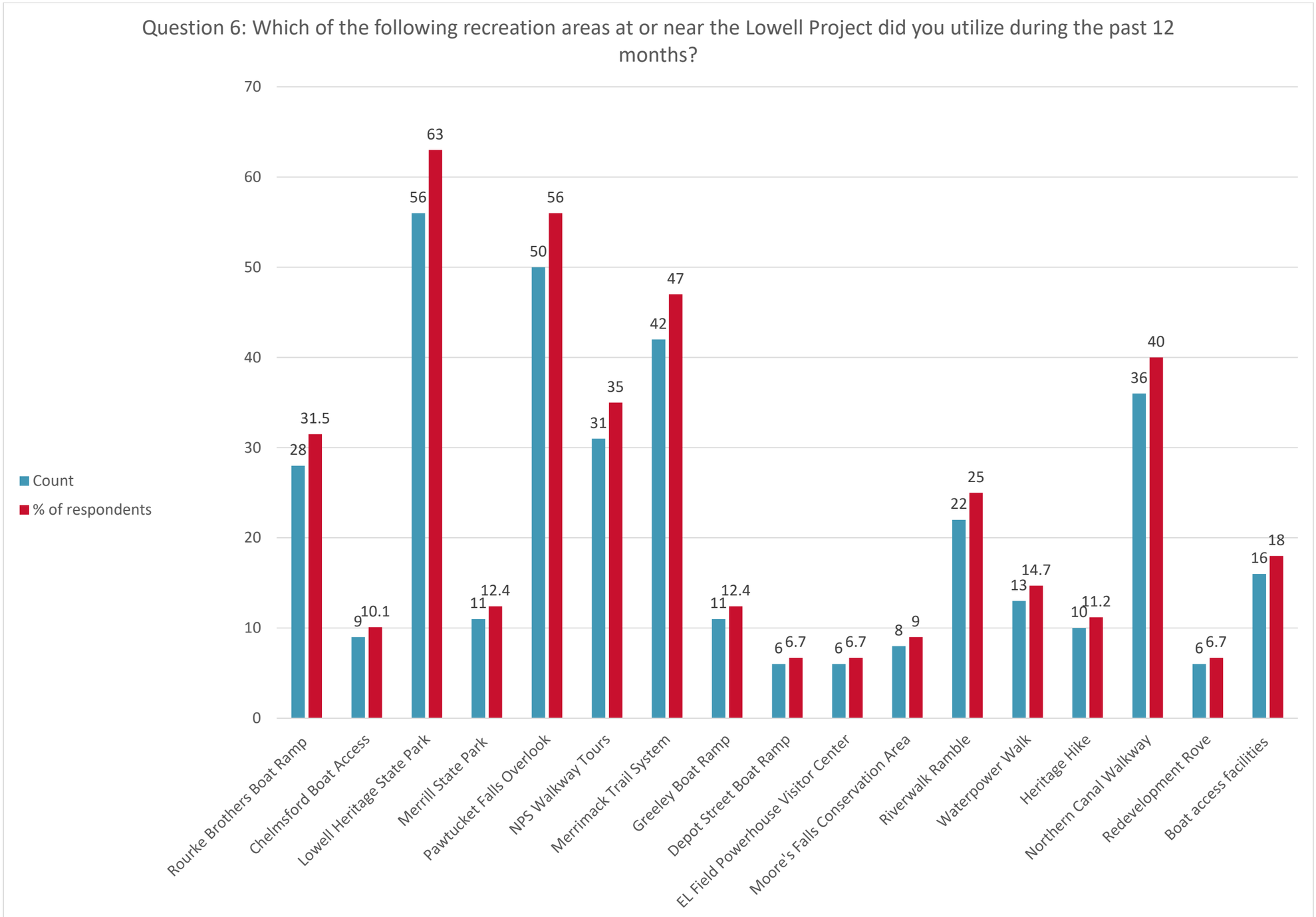
Appendix E - Online Recreation Survey Data

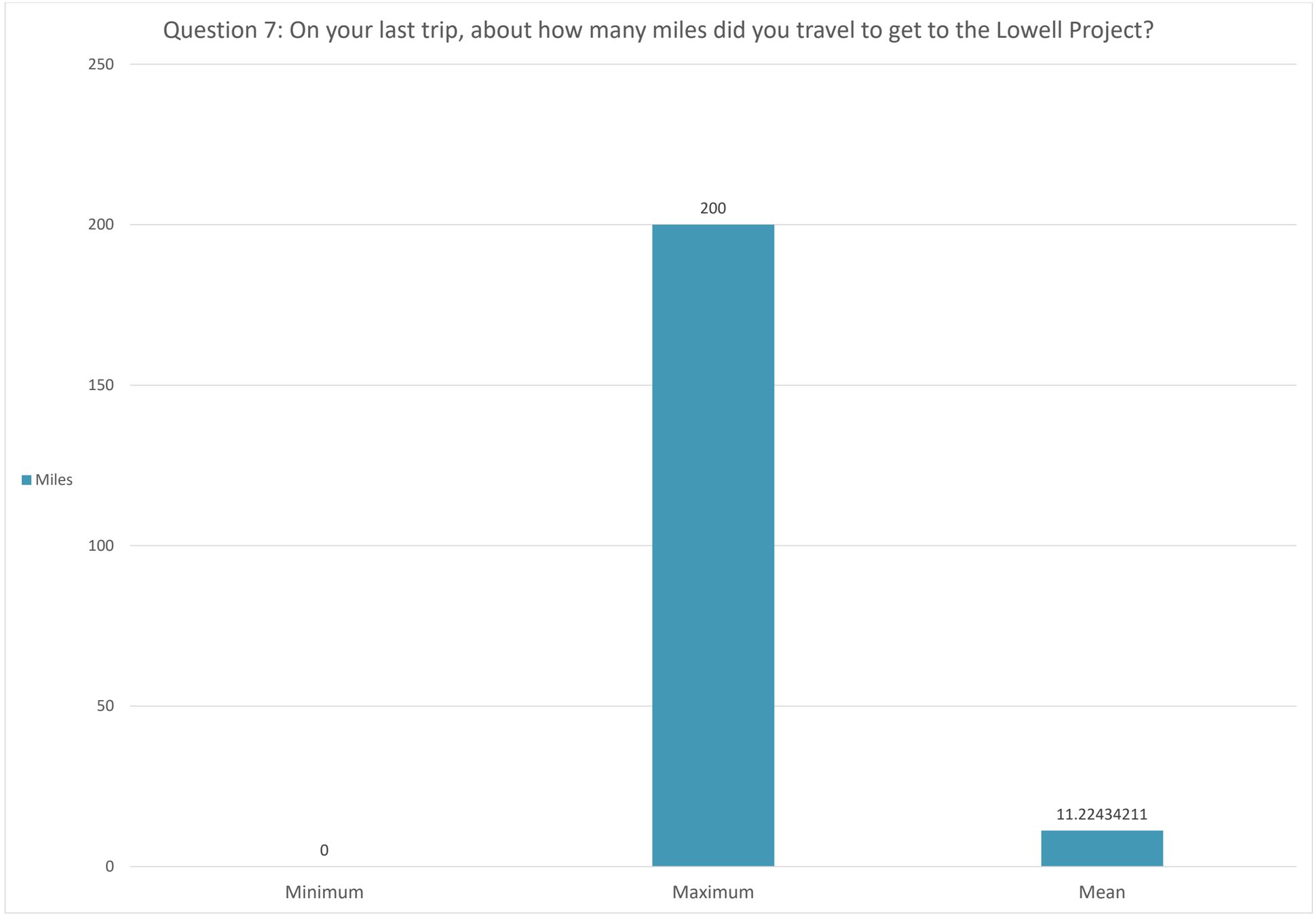

Question 2: What is your age?
100
90
80
70
60
50
40
30
20
10
0
Age (years)
19
89
48.54444444
Minimum
Maximum
Mean


Question 3: What is your gender?
60
50
40
30
20
10
0
42
43.8
49
51
5
5.2
Female
Male
Prefer not to answer
Count
% of respondents

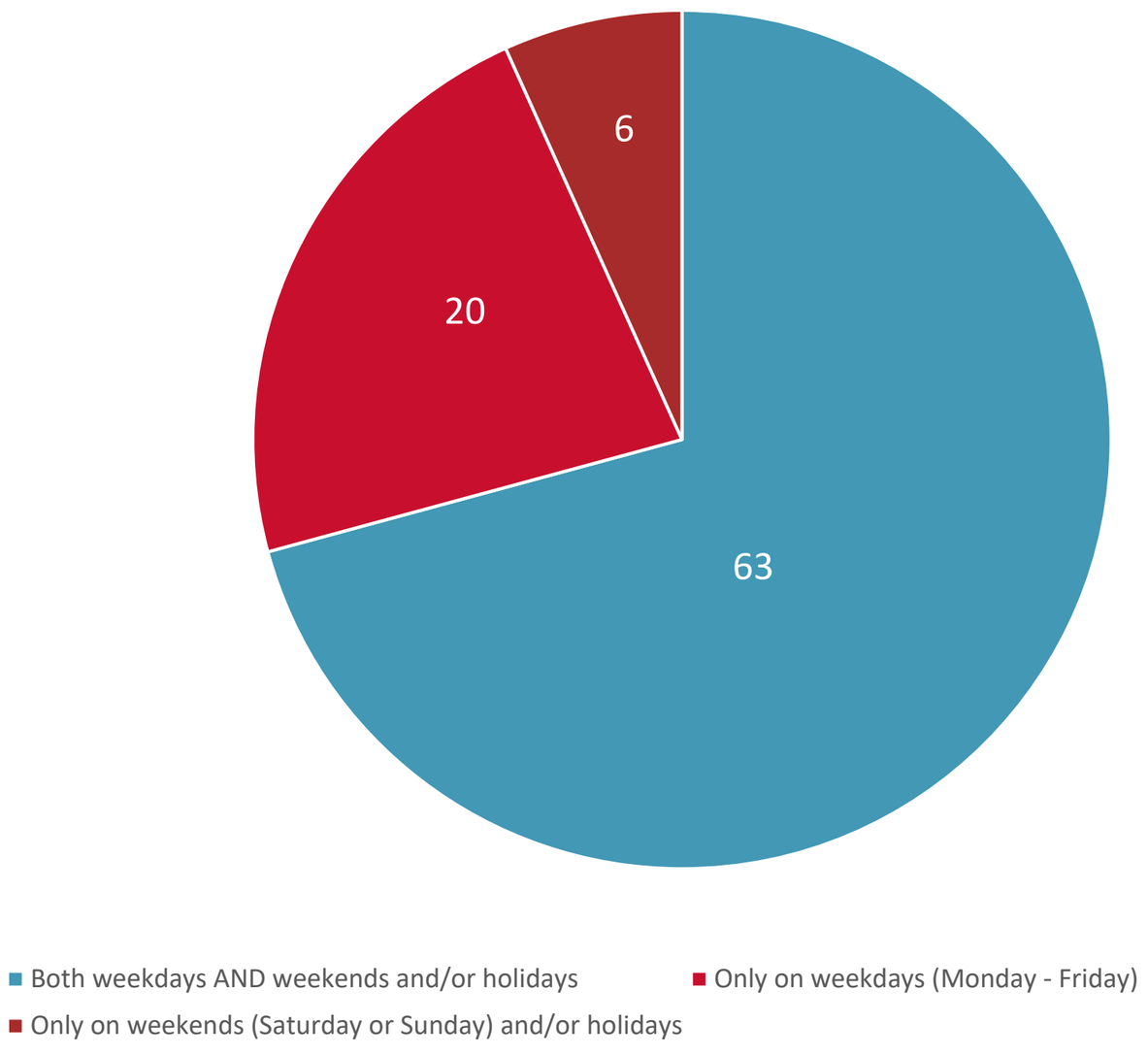

Question 4: Regarding the Lowell Project area, do you consider yourself:
5
17
69
A regular visitor to this area (3 or more times per year)
An occasional visitor (1-2 times per year)
An infrequent visitor (Less than 1 time per year)

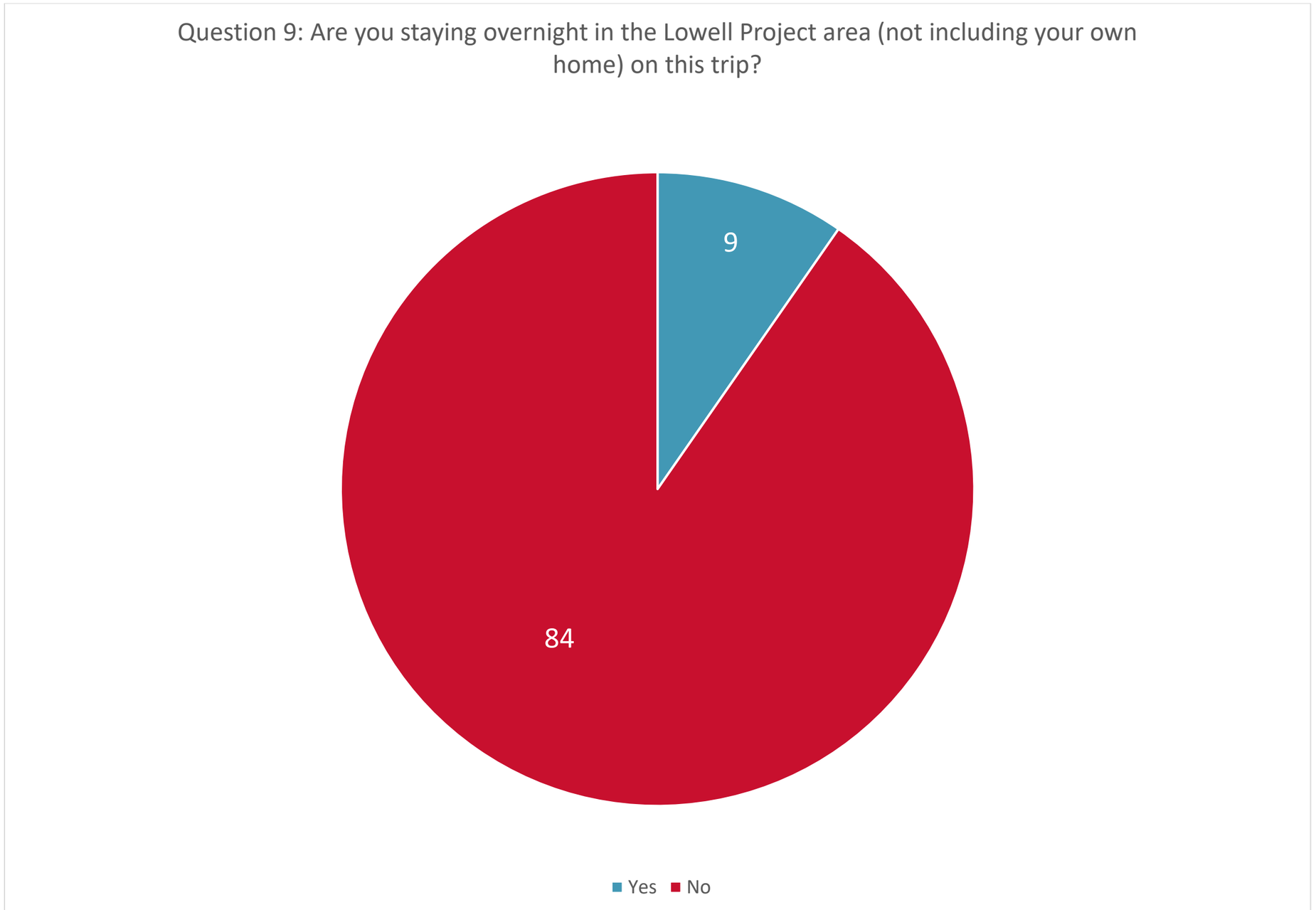

Question 5: During the last 12 months, which month(s) did you visit the Lowell Project area?
Count
% of respondents
80
70
60
50
40
30
20
10
0
41
44.5
41
44.5
52
56.5
63
68.5
70
76
61
66.3
63
68.5
57
70
62
67
60
65
49
53
42
45.6
4
4.3
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
I have not visited the Lowell Project area in the last 12 months

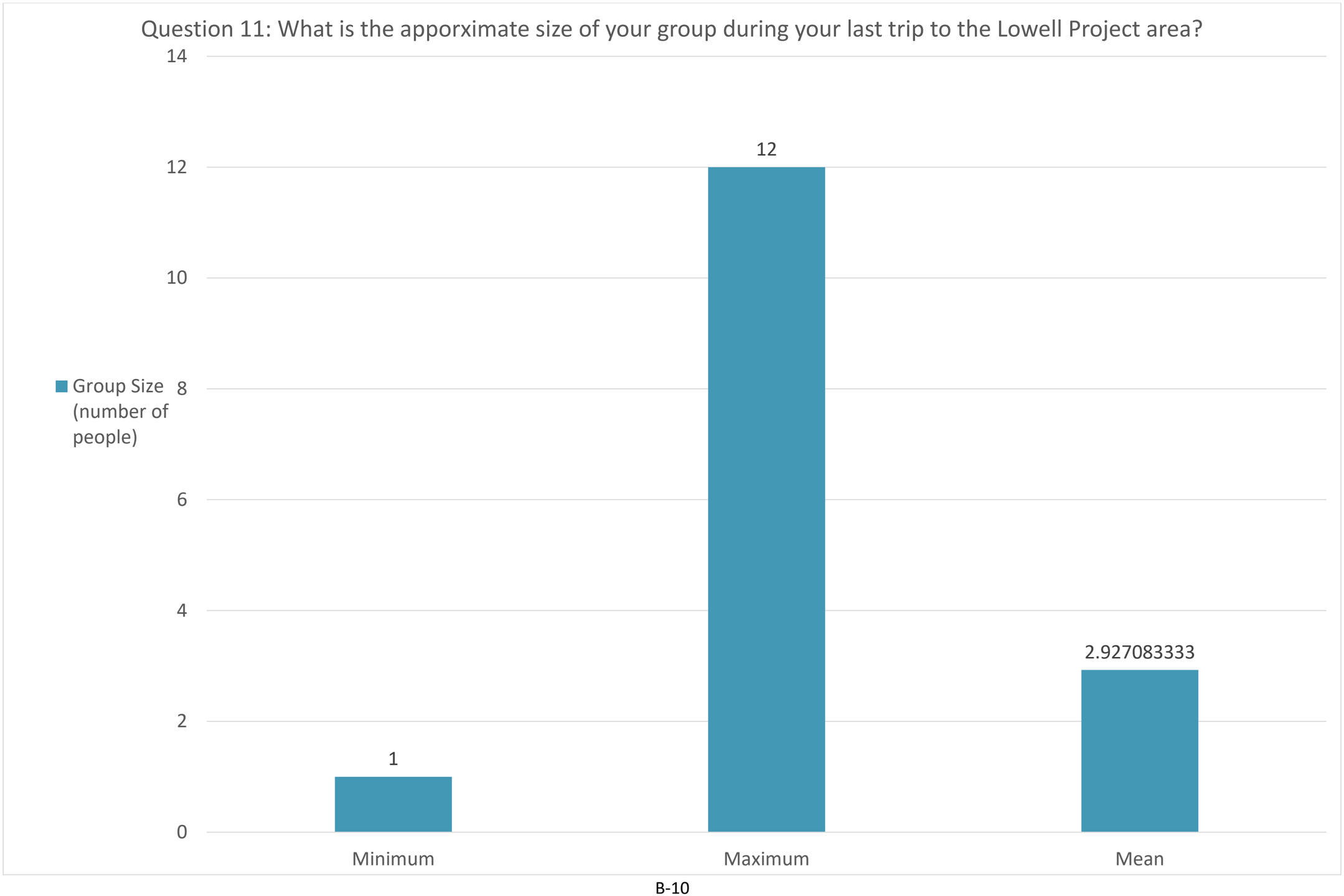

Question 6: Which of the following recreation areas at or near the Lowell Project did you utilize during the past 12 months?
Count
% of respondents
70
60
50
40
30
20
10
0
28
31.5
9
10.1
56
63
11
12.4
50
56
31
35
42
47
11
12.4
6
6.7
6
6.7
8
9
22
25
13
14.7
10
11.2
36
40
6
6.7
16
18
Rourke Brothers Boat Ramp
Chelmsford Boat Access
Lowell Heritage State Park
Merrill State Park
Pawtucket Falls Overlook
NPS Walkway Tours
Merrimack Trail System
Greeley Boat Ramp
Depot Street Boat Ramp
EL Field Powerhouse Visitor Center
Moore's Falls Conservation Area
Riverwalk Ramble
Waterpower Walk
Heritage Hike
Northern Canal Walkway
Redevelopment Rove
Boat access facilities

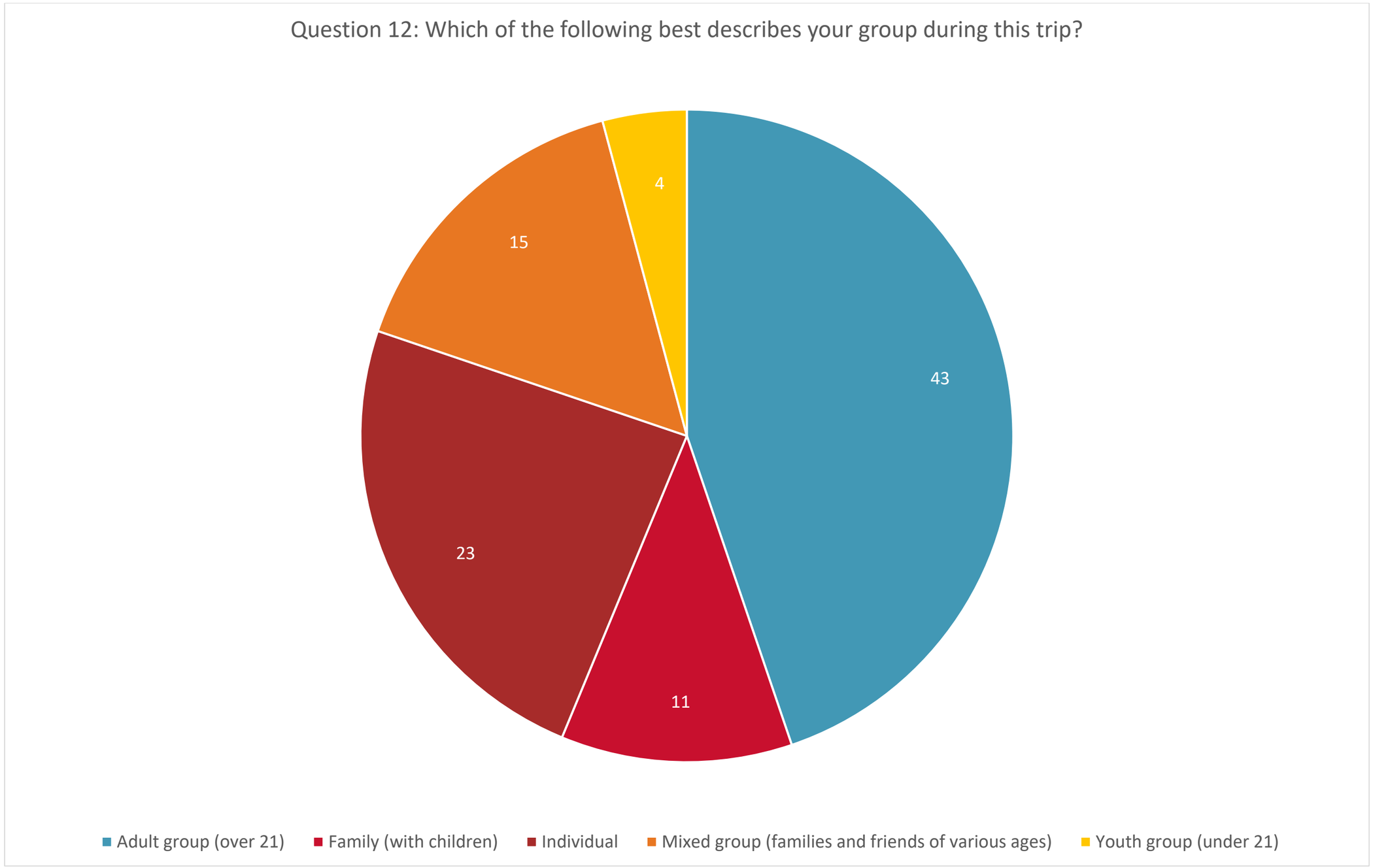

Question 7: On your last trip, about how many miles did you travel to get to the Lowell Project?
250
200
150
100
50
0
Miles
200
0
11.22434211
Minimum
Maximum
Mean

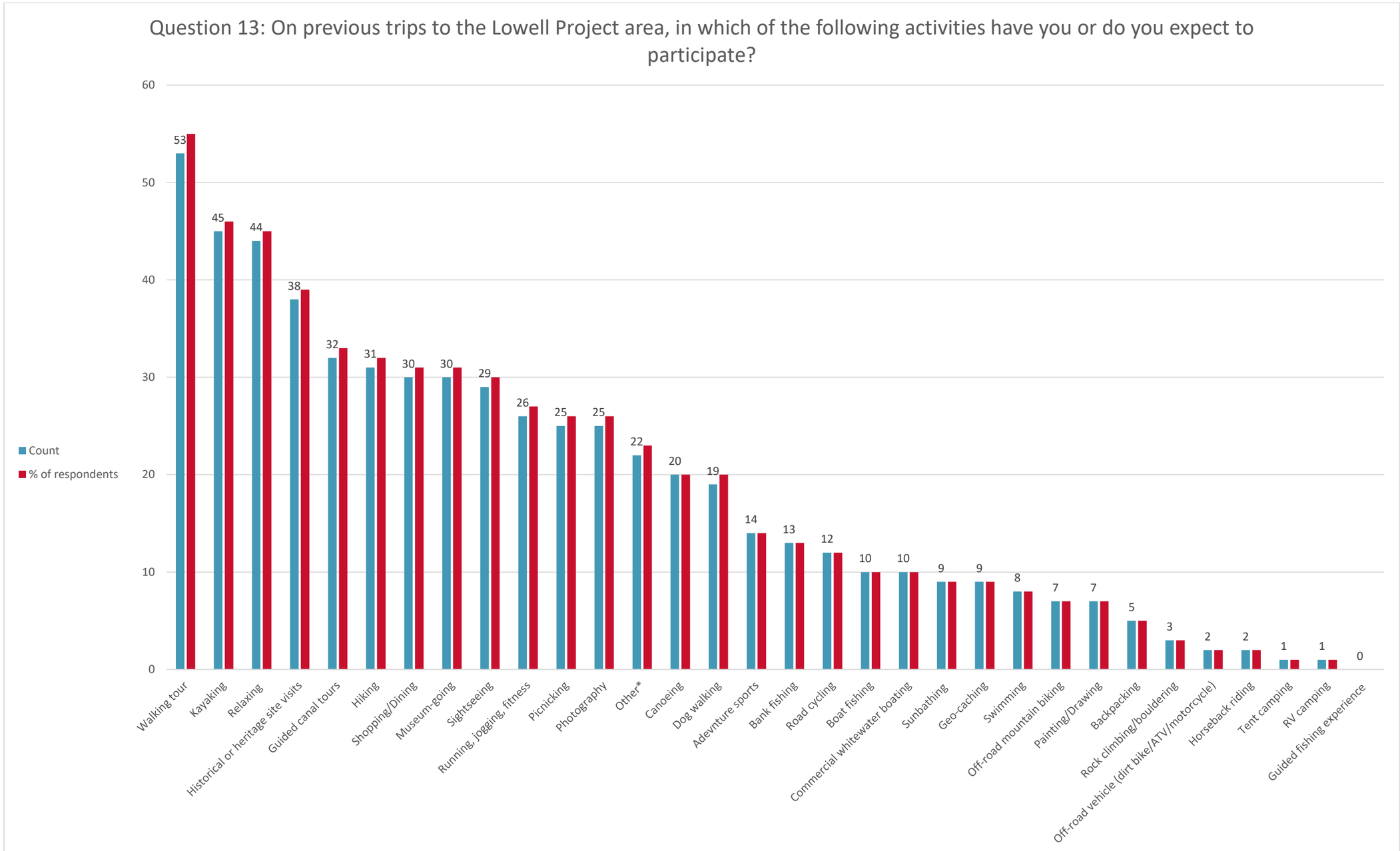
Question 8: During the past 12 months, when did you visit the Lowell Project? (Please select one)



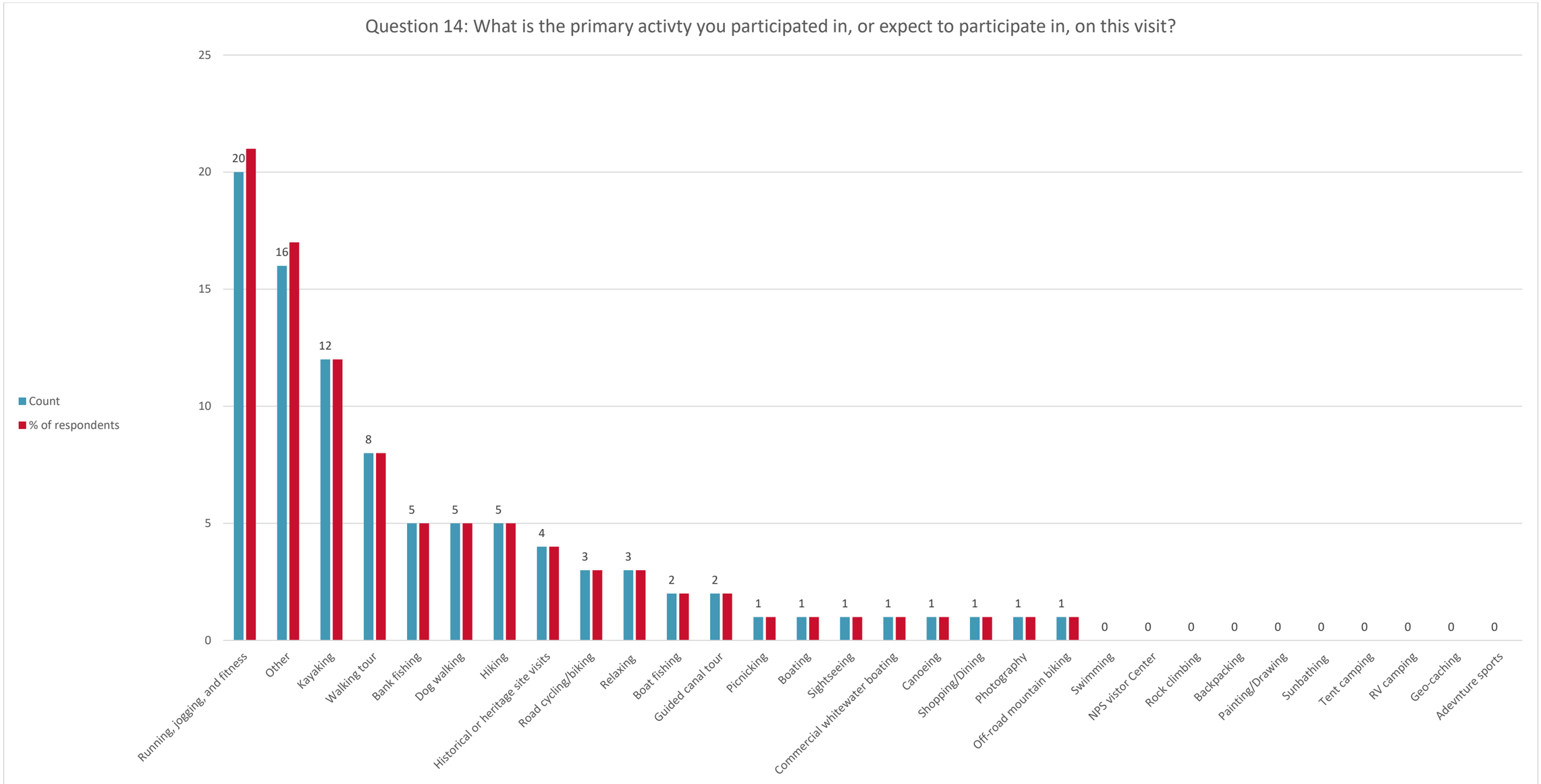

Question 9: Are you staying overnight in the Lowell Project area (not including your own home) on this trip?
9
84
Yes
No

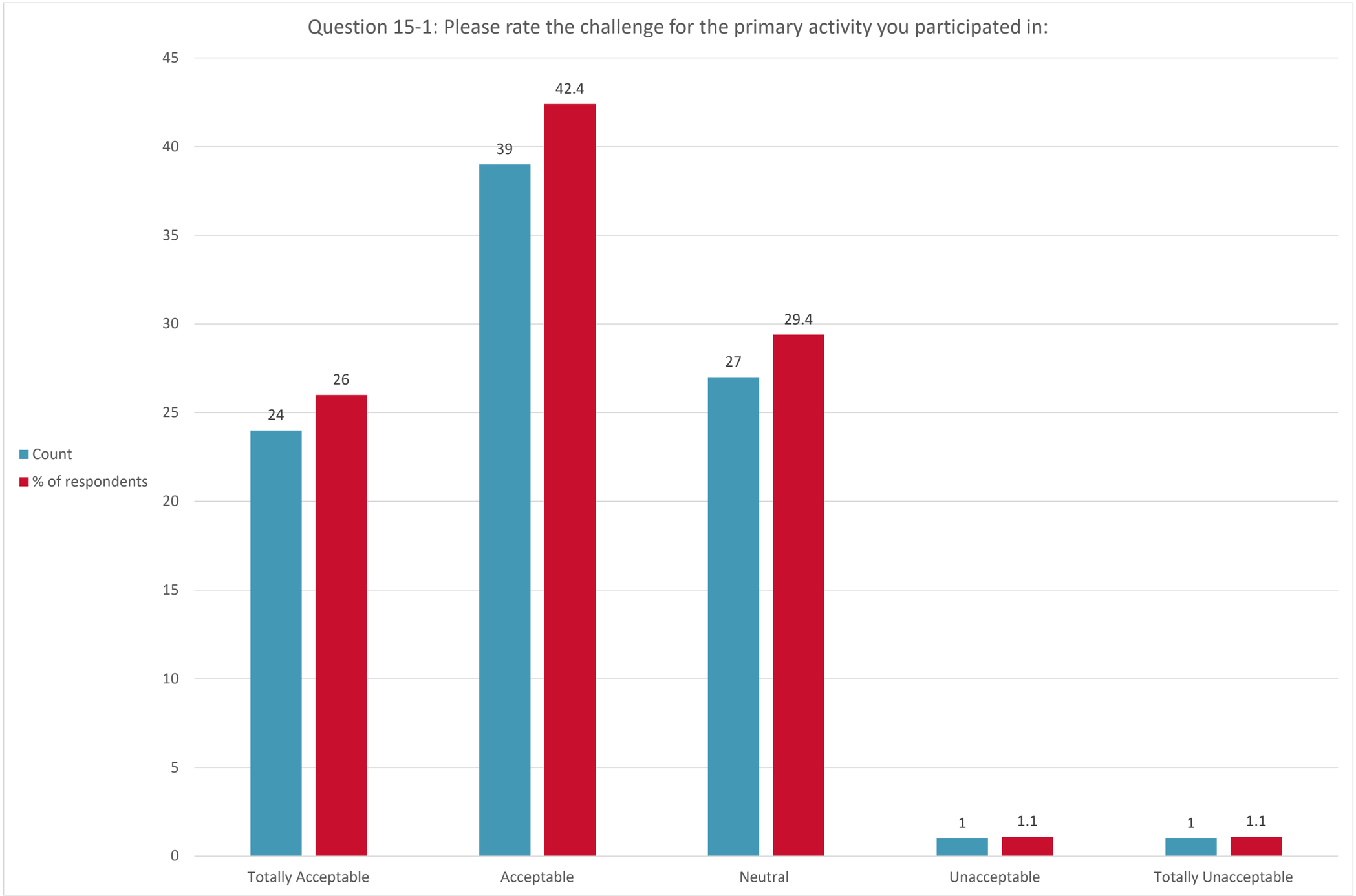

Question 11: What is the apporximate size of your group during your last trip to the Lowell Project area?
14
12
10
8
6
4
2
0
Group Size (number of people)
12
1
2.927083333
Minimum
Maximum
Mean

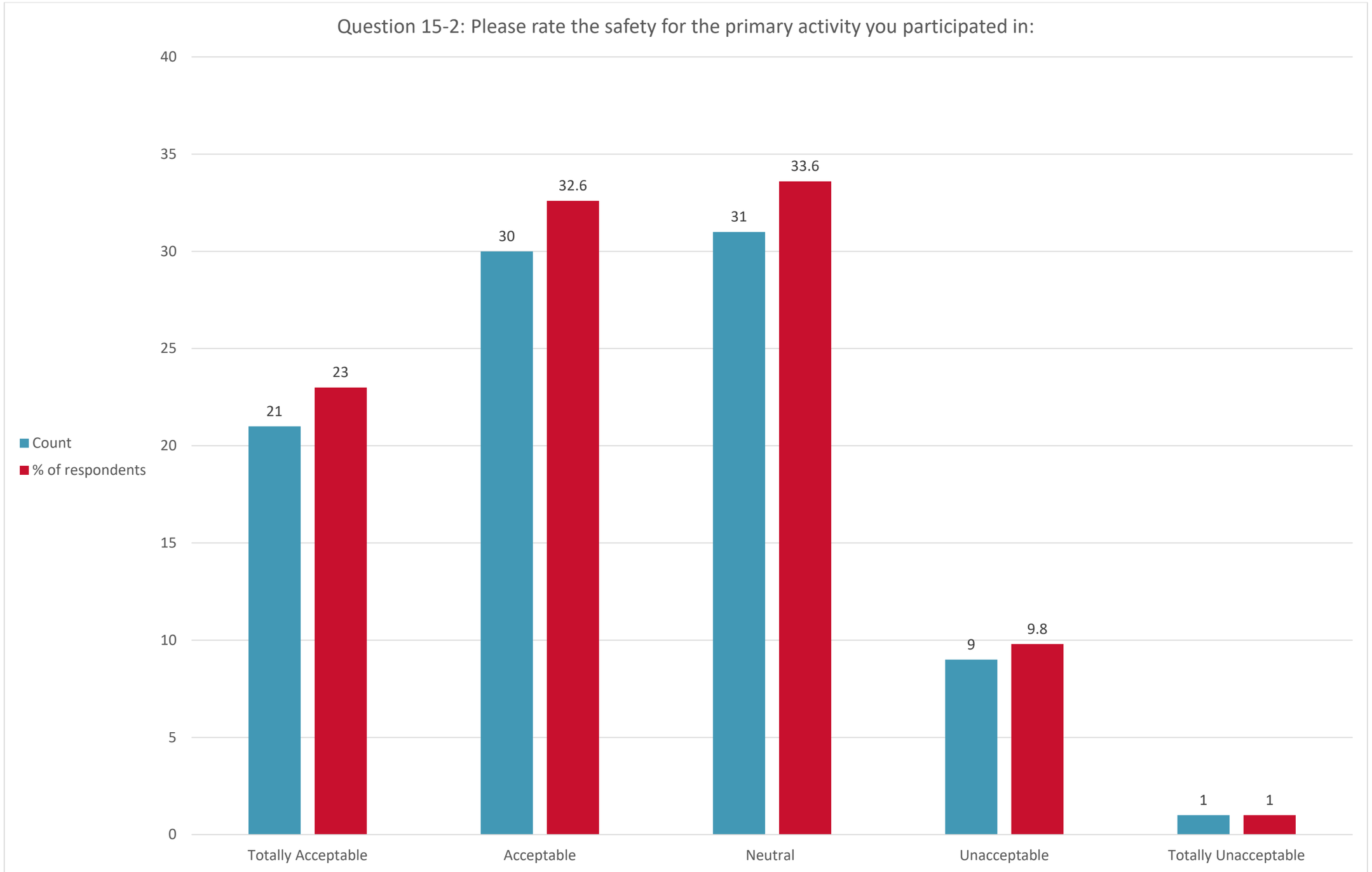

Question 12: Which of the following best describes your group during this trip?
43
11
23
15
4
Adult group (over 21)
Family (with children)
Individual
Mixed group (families and friends of various ages)
Youth group (under 21)

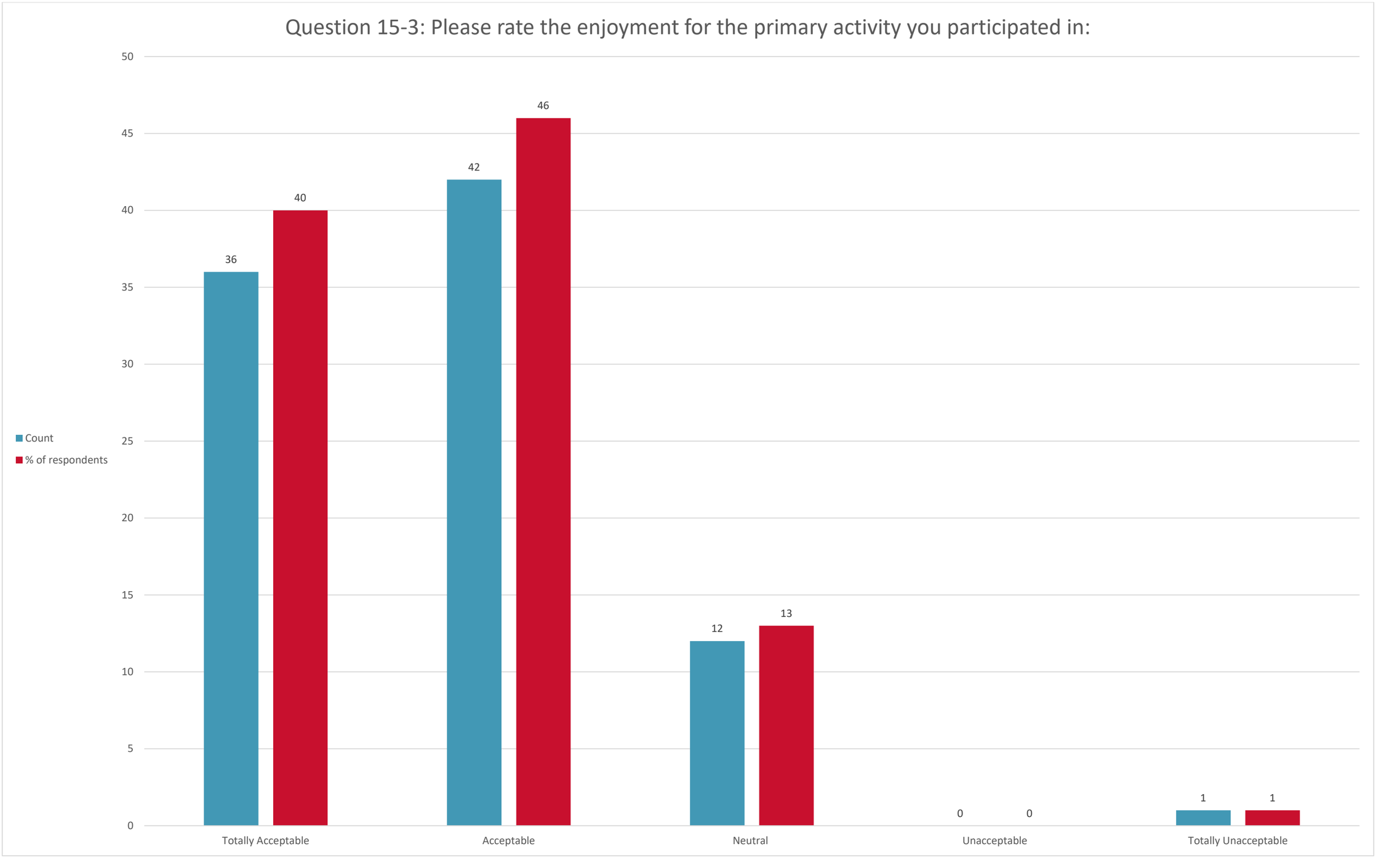


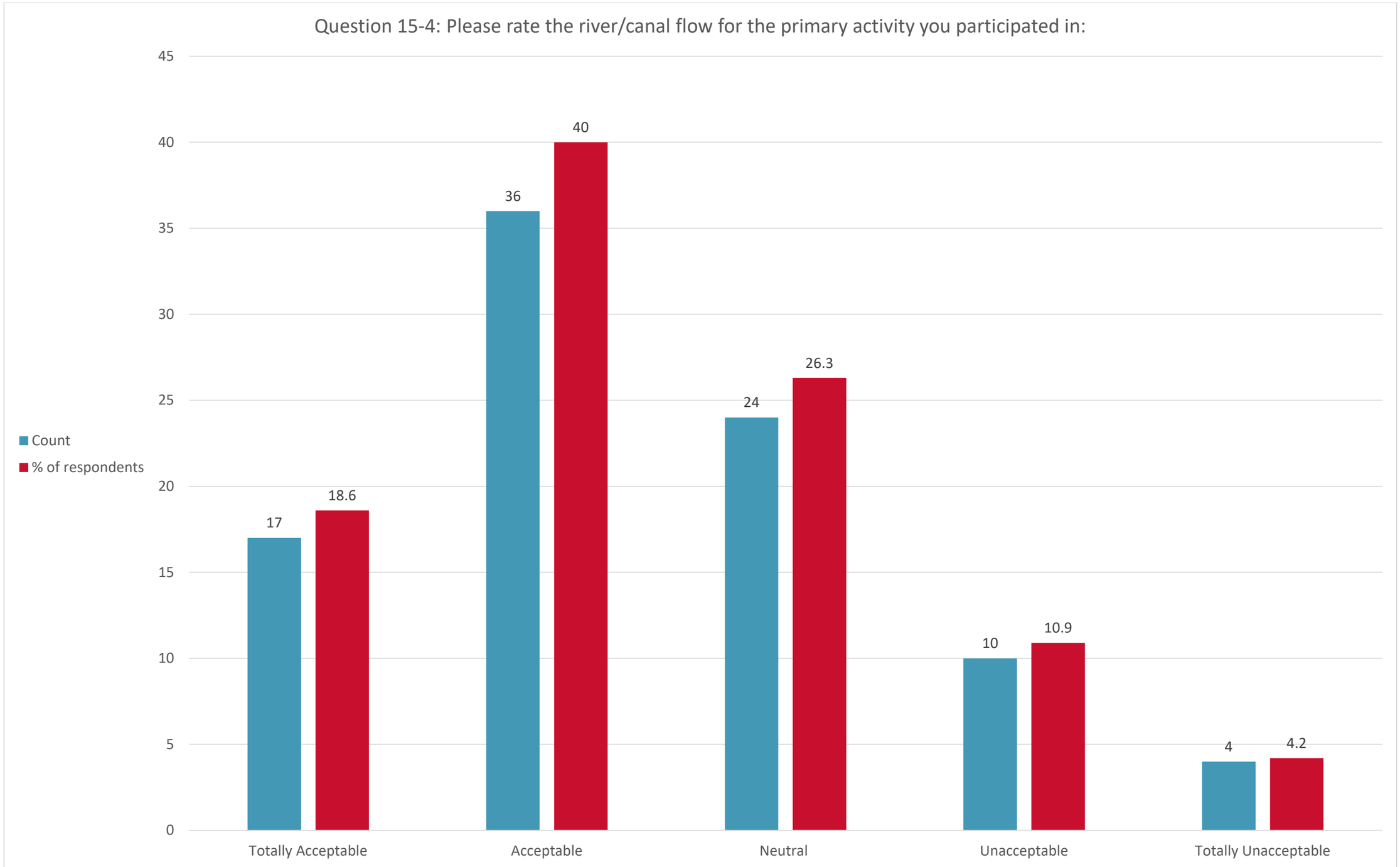
*Other responses included personal whitewater rafting or canoeing, hammocking, birding, attending festivals, and sport boating.

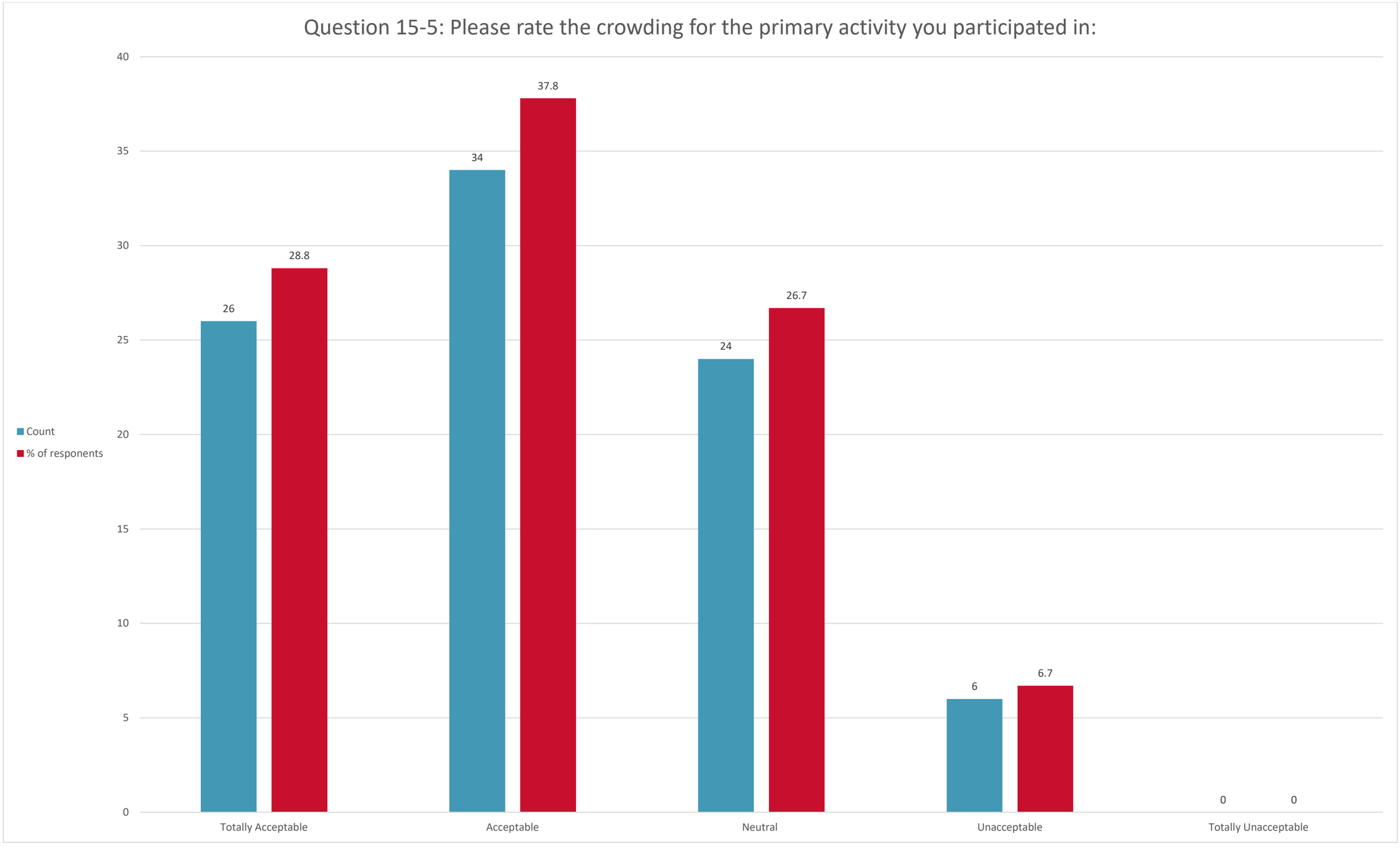

Question 14: What is the primary activty you participated in, or expect to participate in, on this visit?
Count
% of respondents
25
20
15
10
5
0
20
16
12
8
5
5
5
4
3
3
2
2
1
1
1
1
1
1
1
1
0
0
0
0
0
0
0
0
0
0
Running, jogging, and fitness
Other
Kayaking
Walking tour
Bank fishing
Dog walking
Hiking
Historical or heritage site visits
Road cycling/biking
Relaxing
Boat fishing
Guided canal tour
Picnicking
Boating
Sightseeing
Commercial whitewater boating
Canoeing
Shopping/Dining
Photography
Off-road mountain biking
Swimming
NPS vistor Center
Rock climbing
Backpacking
Painting/Drawing
Sunbathing
Tent camping
RV camping
Geo-caching
Adevnture sports

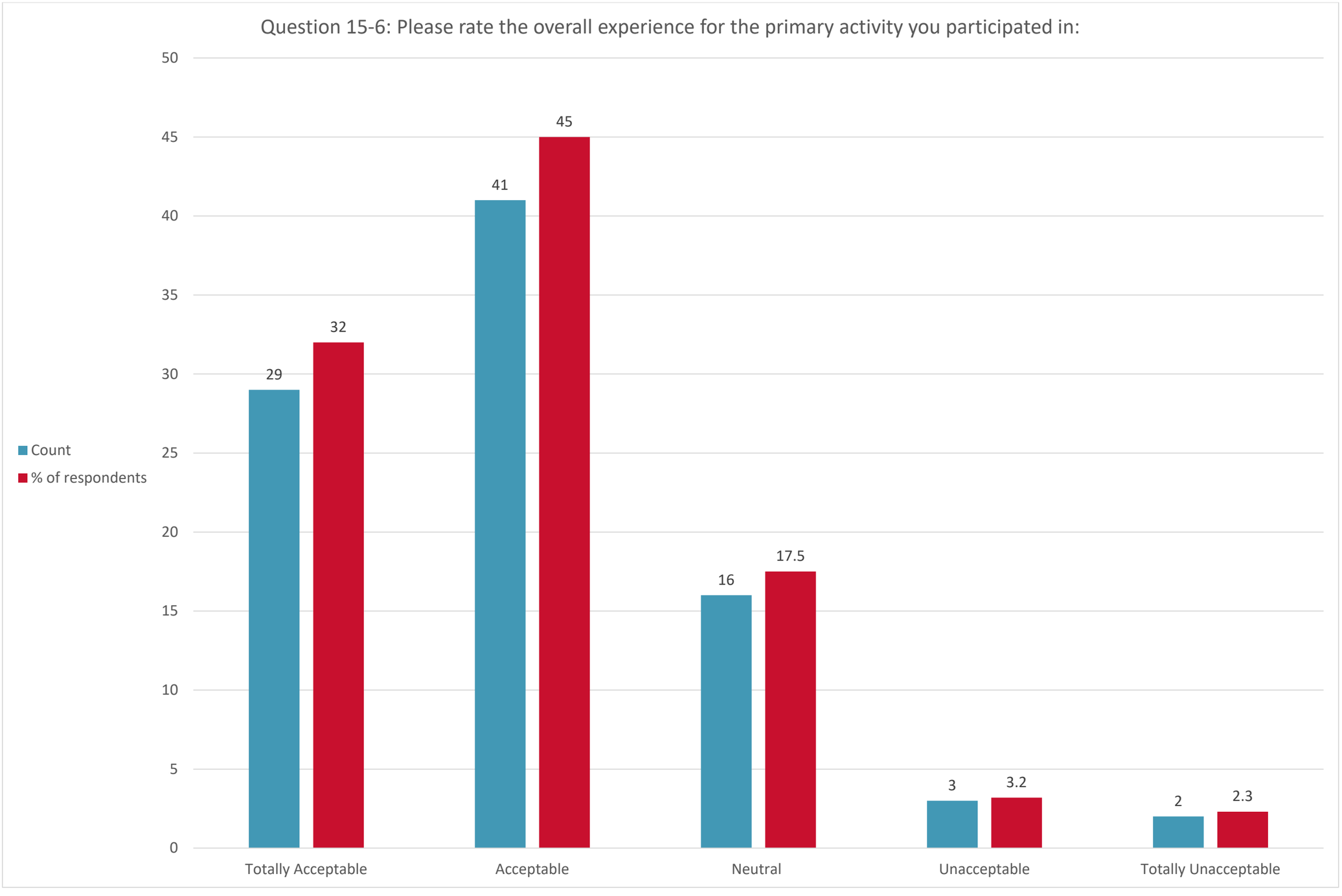

Question 15-1: Please rate the challenge for the primary activity you participated in:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
24
26
39
42.4
27
29.4
1
1.1
1
1.1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

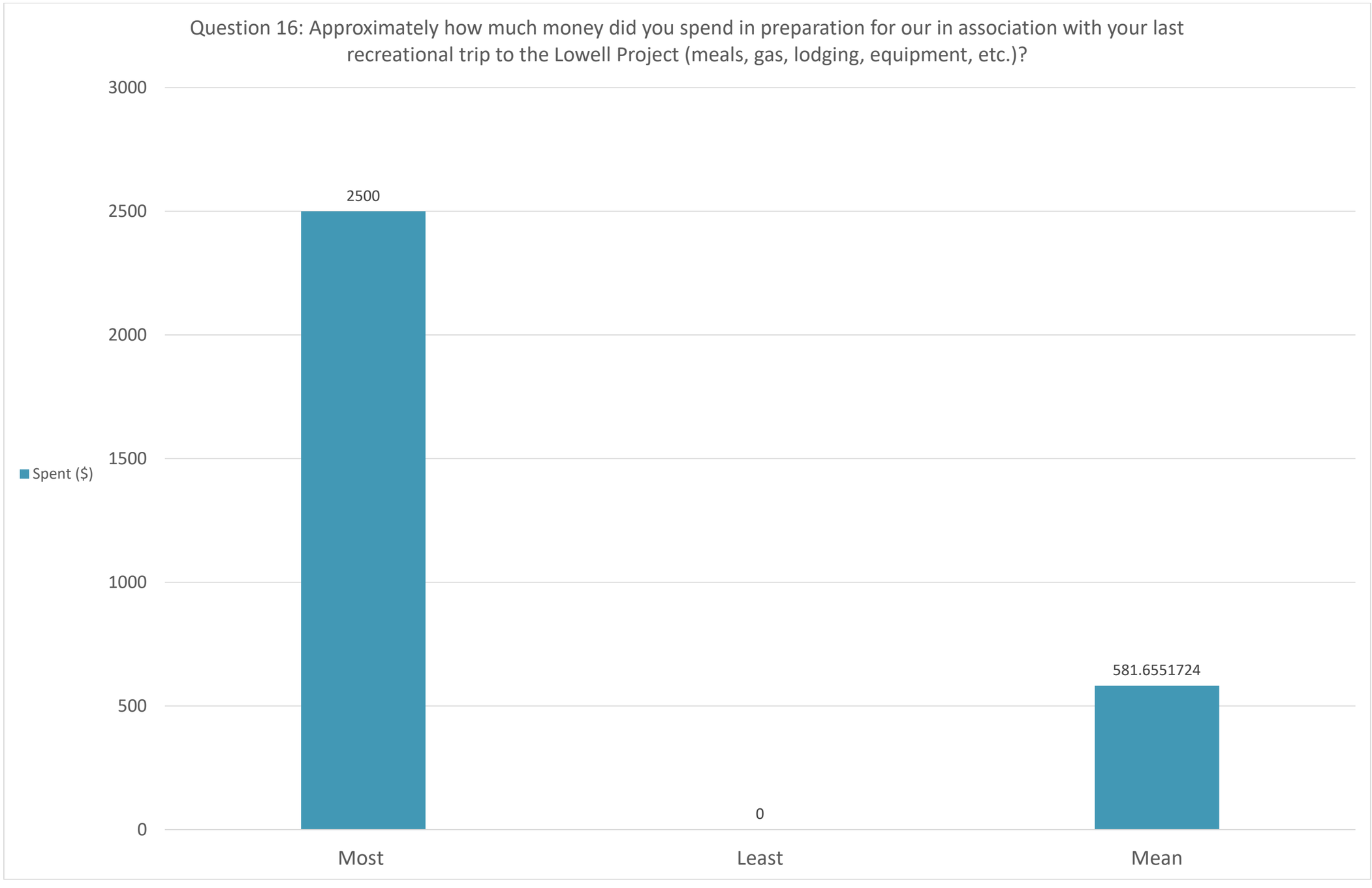

Question 15-2: Please rate the safety for the primary activity you participated in:
Count
% of respondents
40
35
30
25
20
15
10
5
0
21
23
30
32.6
31
33.6
9
9.8
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

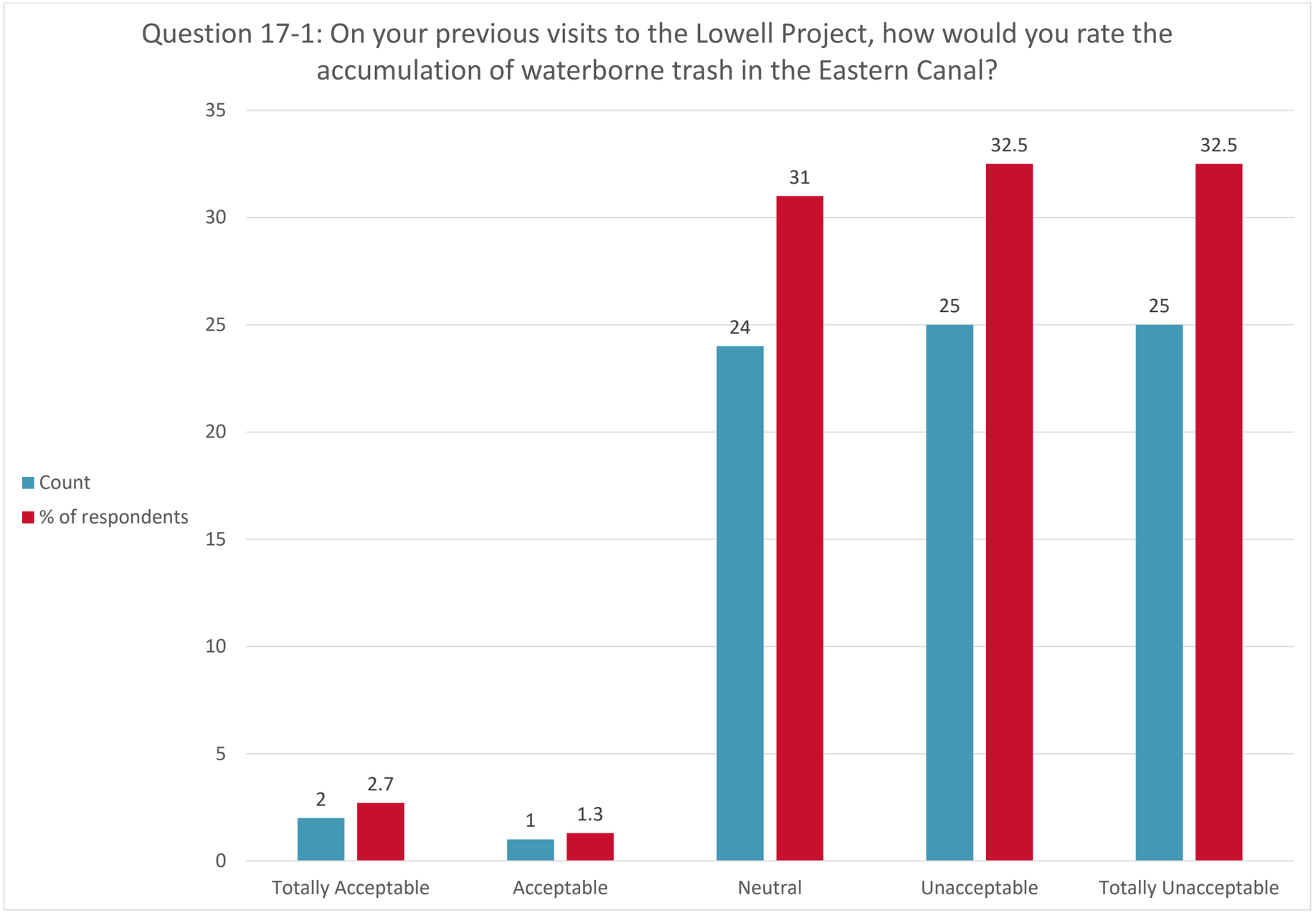

Question 15-3: Please rate the enjoyment for the primary activity you participated in:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
36
40
42
46
12
13
0
0
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

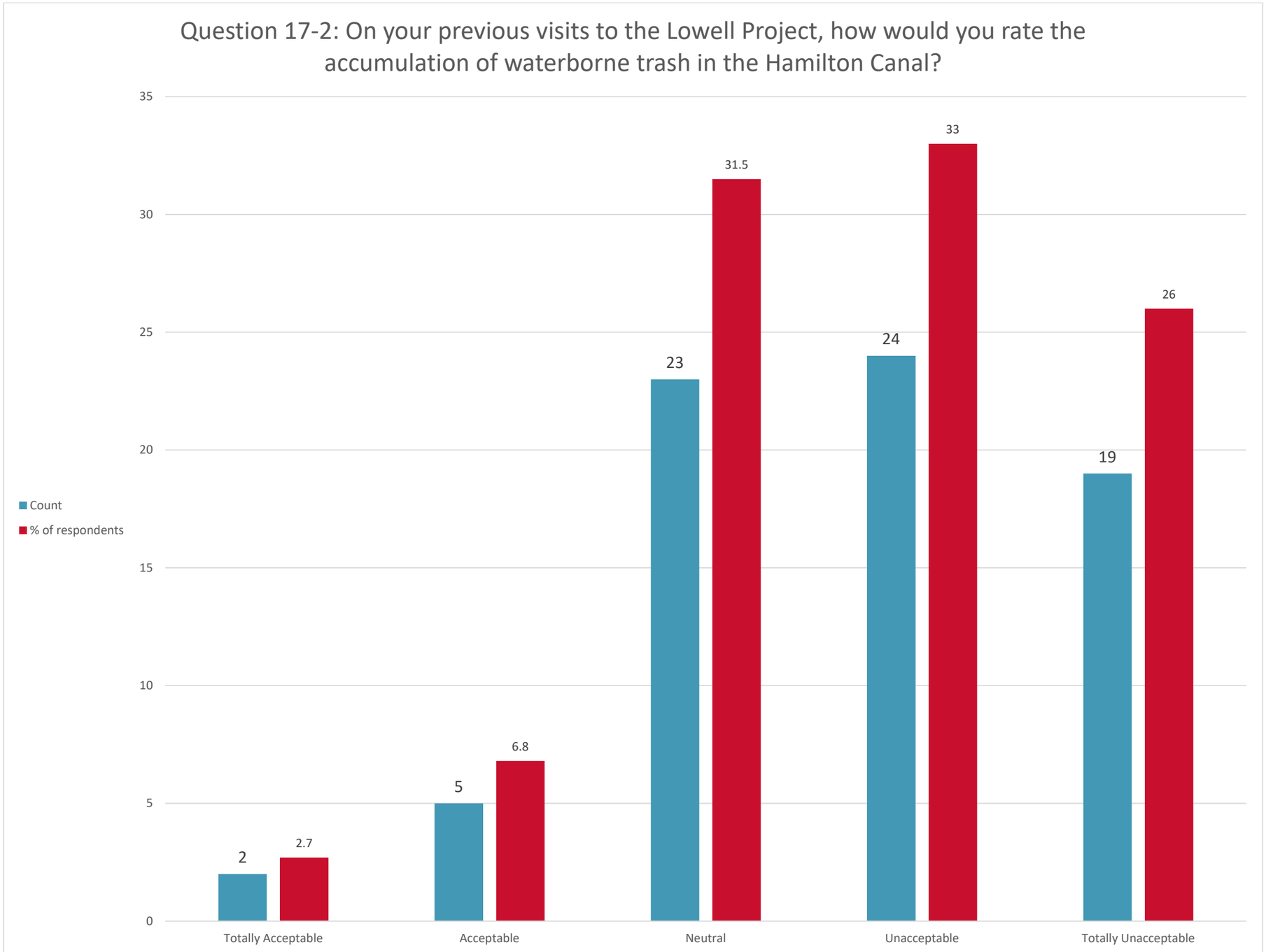

Question 15-4: Please rate the river/canal flow for the primary activity you participated in:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
17
18.6
36
40
24
26.3
10
10.9
4
4.2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

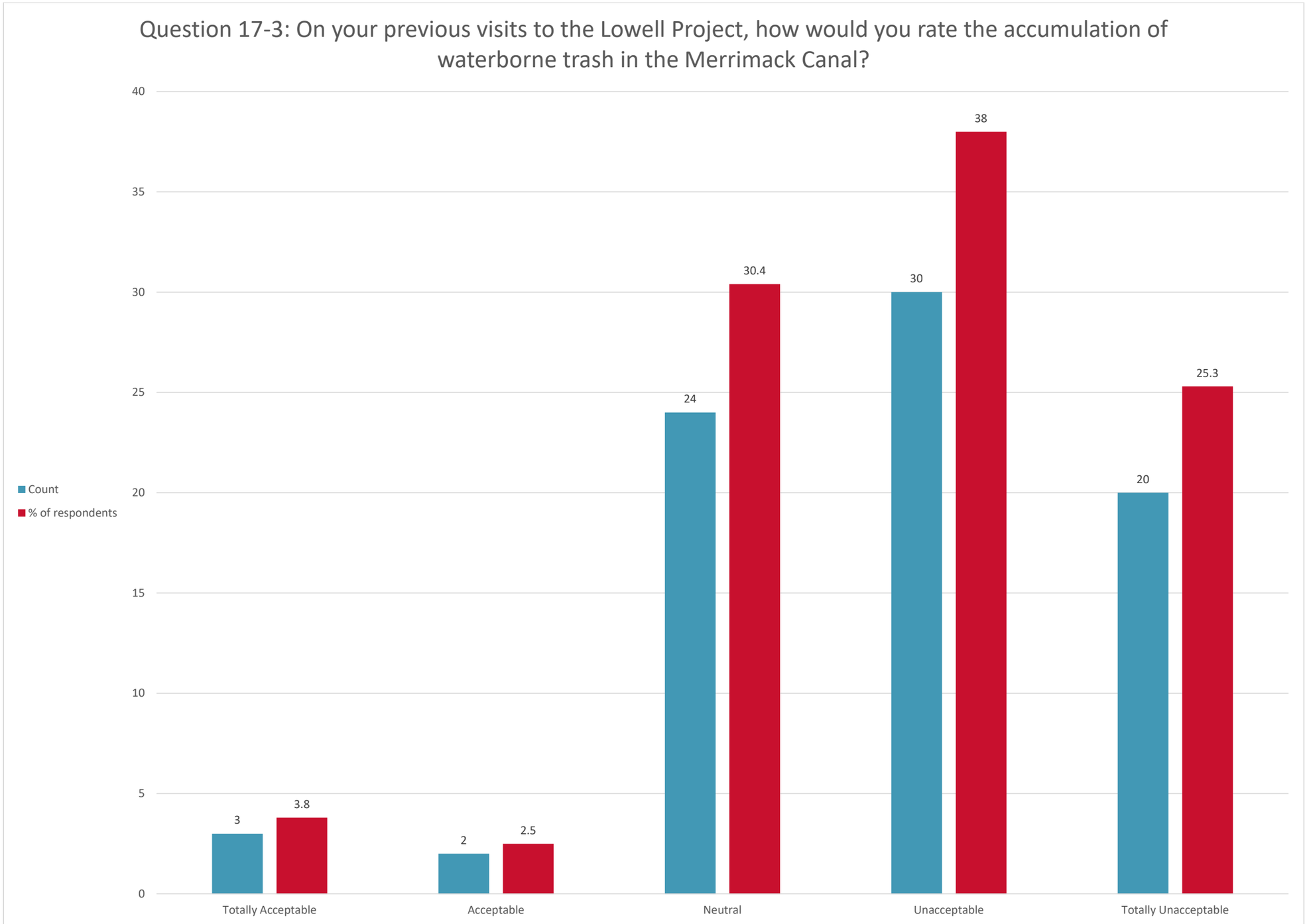

Question 15-5: Please rate the crowding for the primary activity you participated in:
40
35
30
25
20
15
10
5
0
Count
% of responents
26
28.8
34
37.8
24
26.7
6
6.7
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

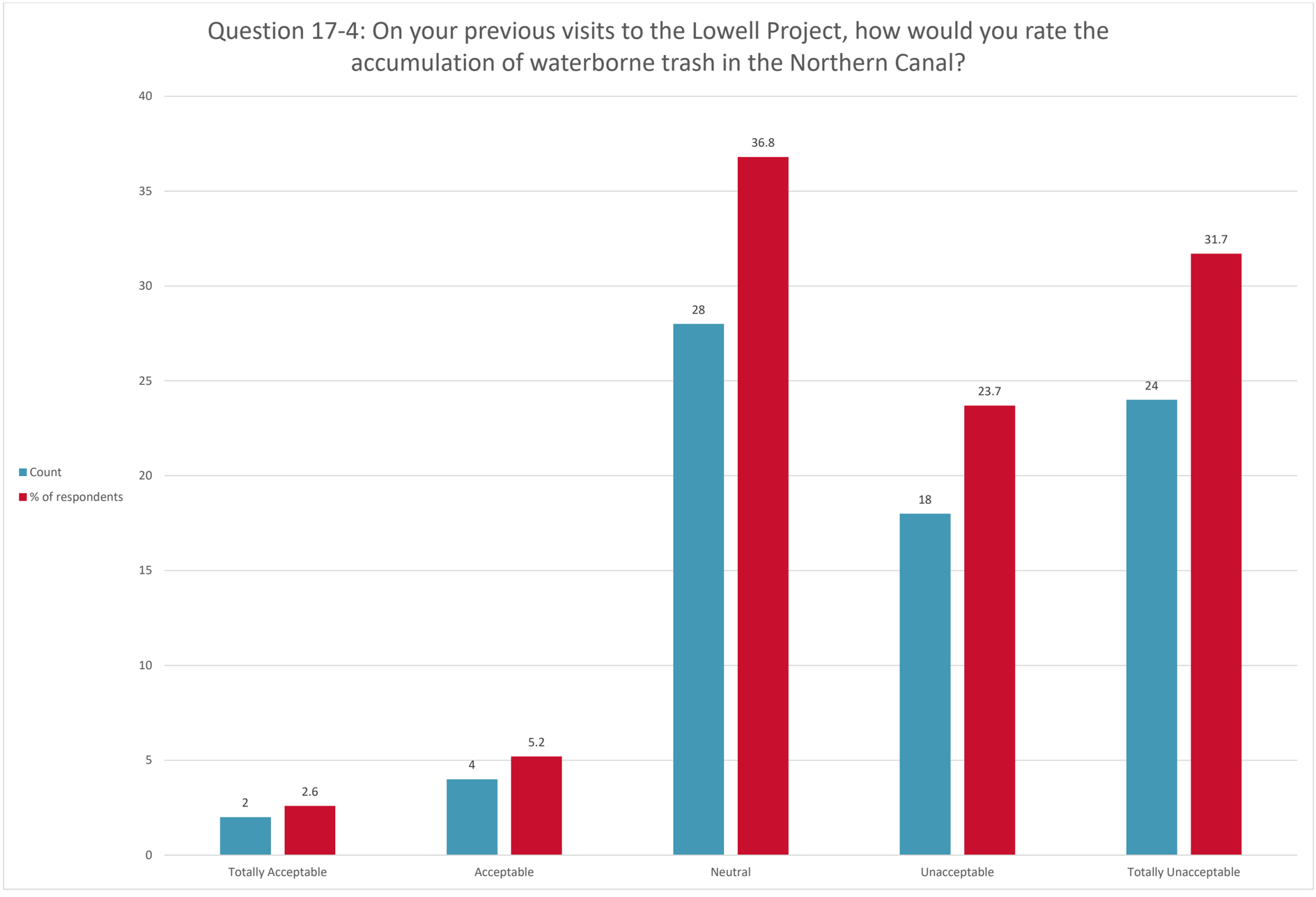

Question 15-6: Please rate the overall experience for the primary activity you participated in:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
29
32
41
45
16
17.5
3
3.2
2
2.3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

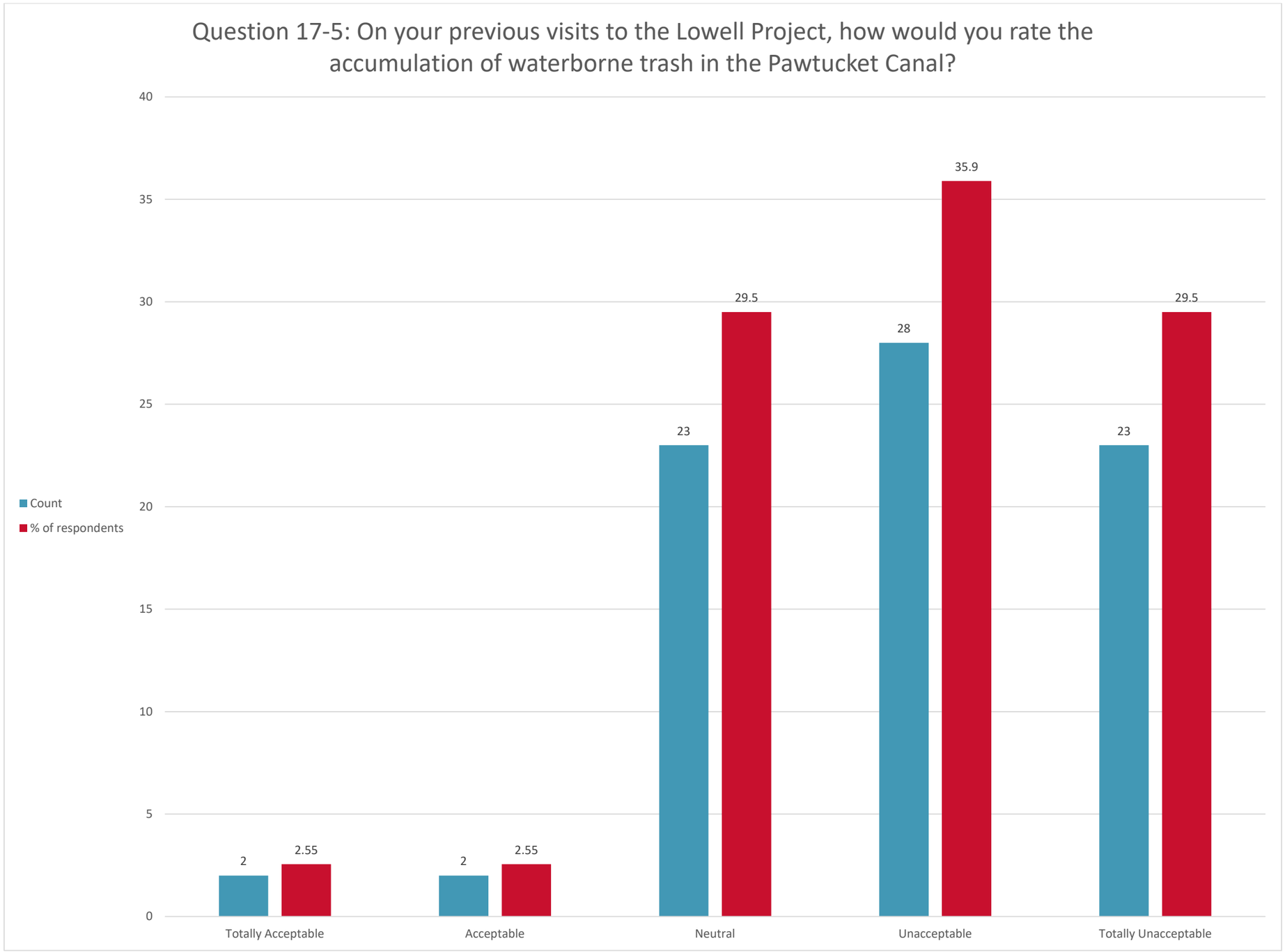

Question 16: Approximately how much money did you spend in preparation for our in association with your last recreational trip to the Lowell Project (meals, gas, lodging, equipment, etc.)?
3000
2500
2000
1500
1000
500
0
Spent ($)
2500
0
581.6551724
Most
Least
Mean

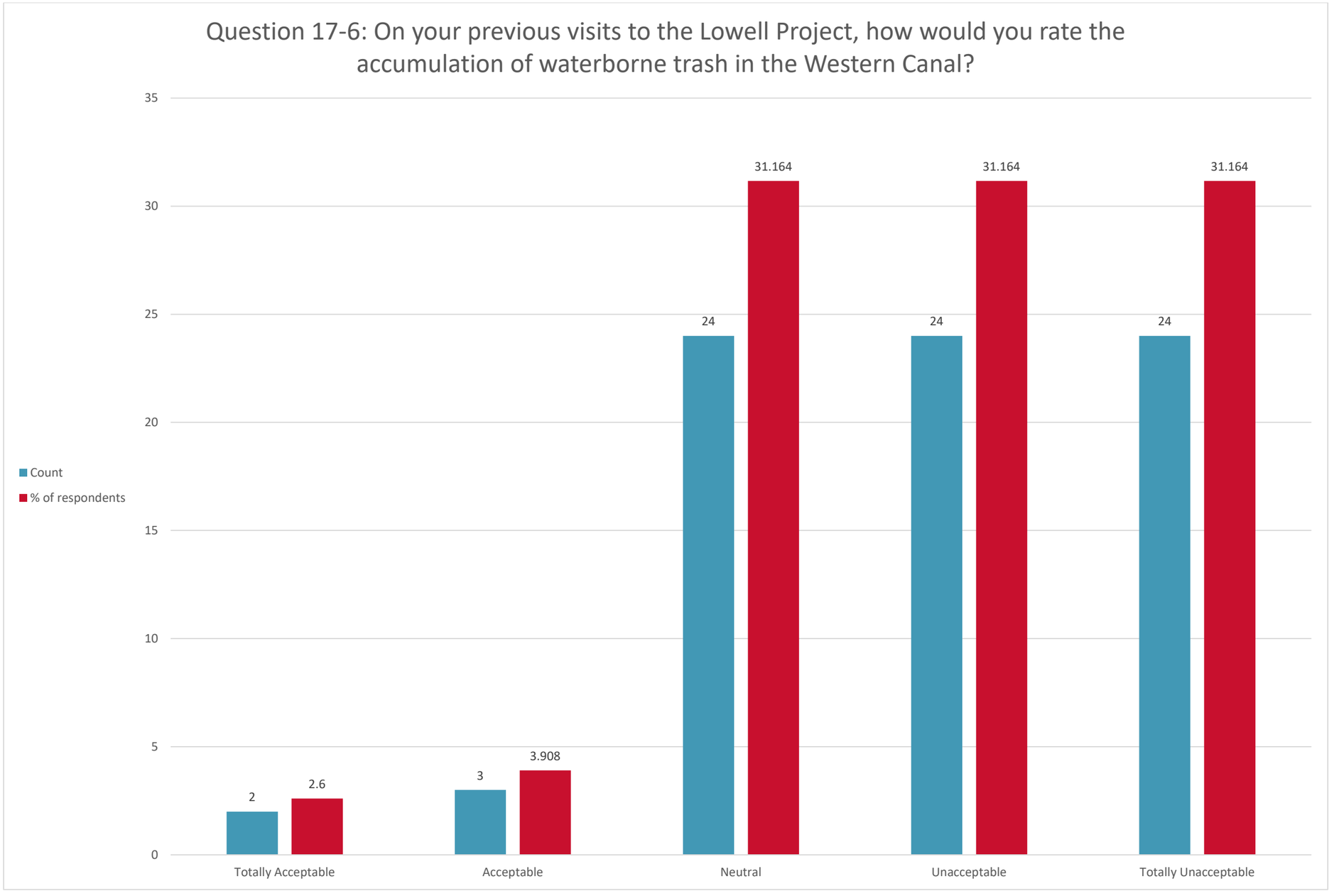

Question 17-1: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Eastern Canal?
35
30
25
20
15
10
5
0
Count
% of respondents
2
2.7
1
1.3
24
31
25
32.5
25
32.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

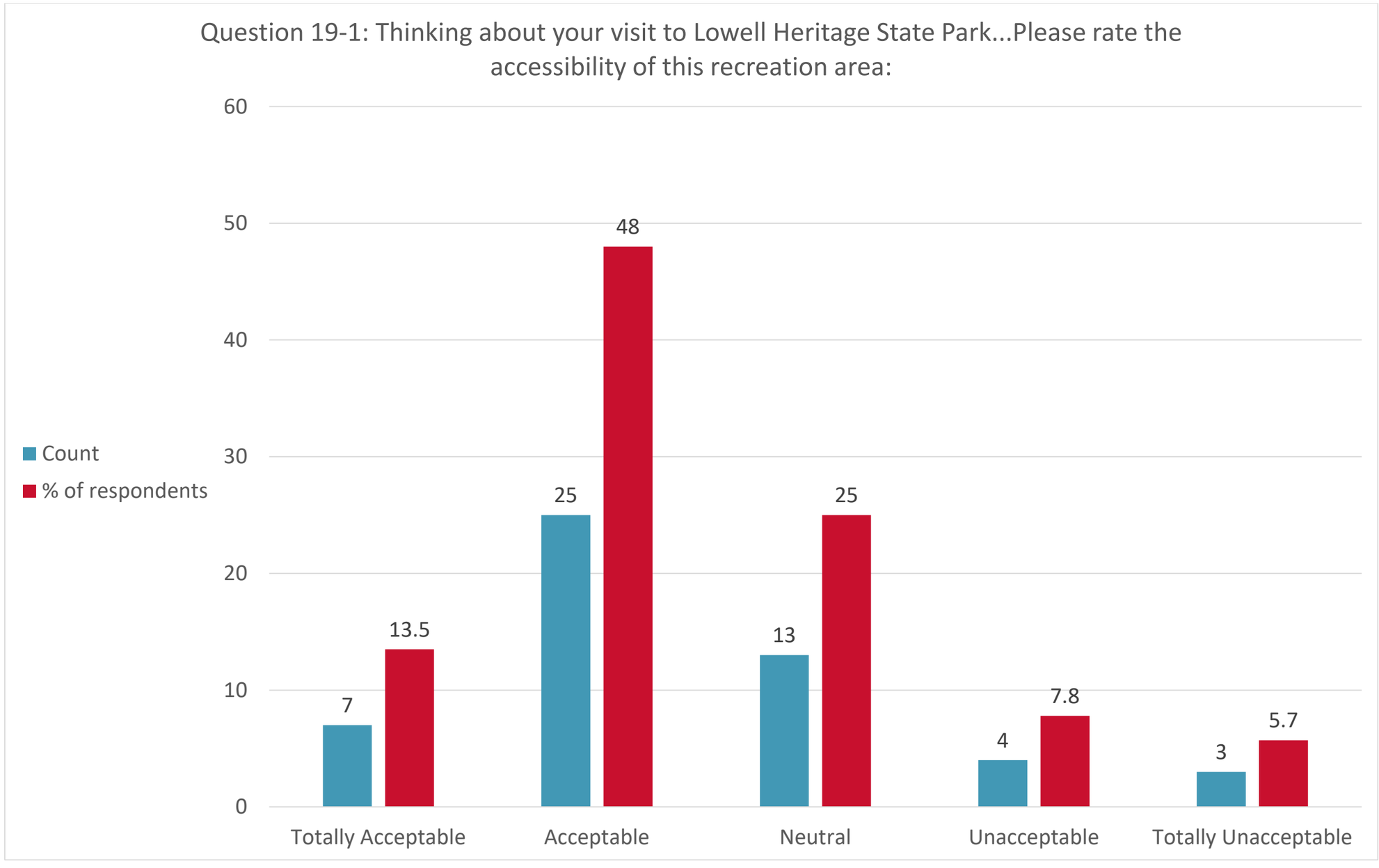

Question 17-2: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Hamilton Canal?
35
30
25
20
15
10
5
0
Count
% of respondents
2
2.7
5
6.8
23
31.5
24
33
19
26
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

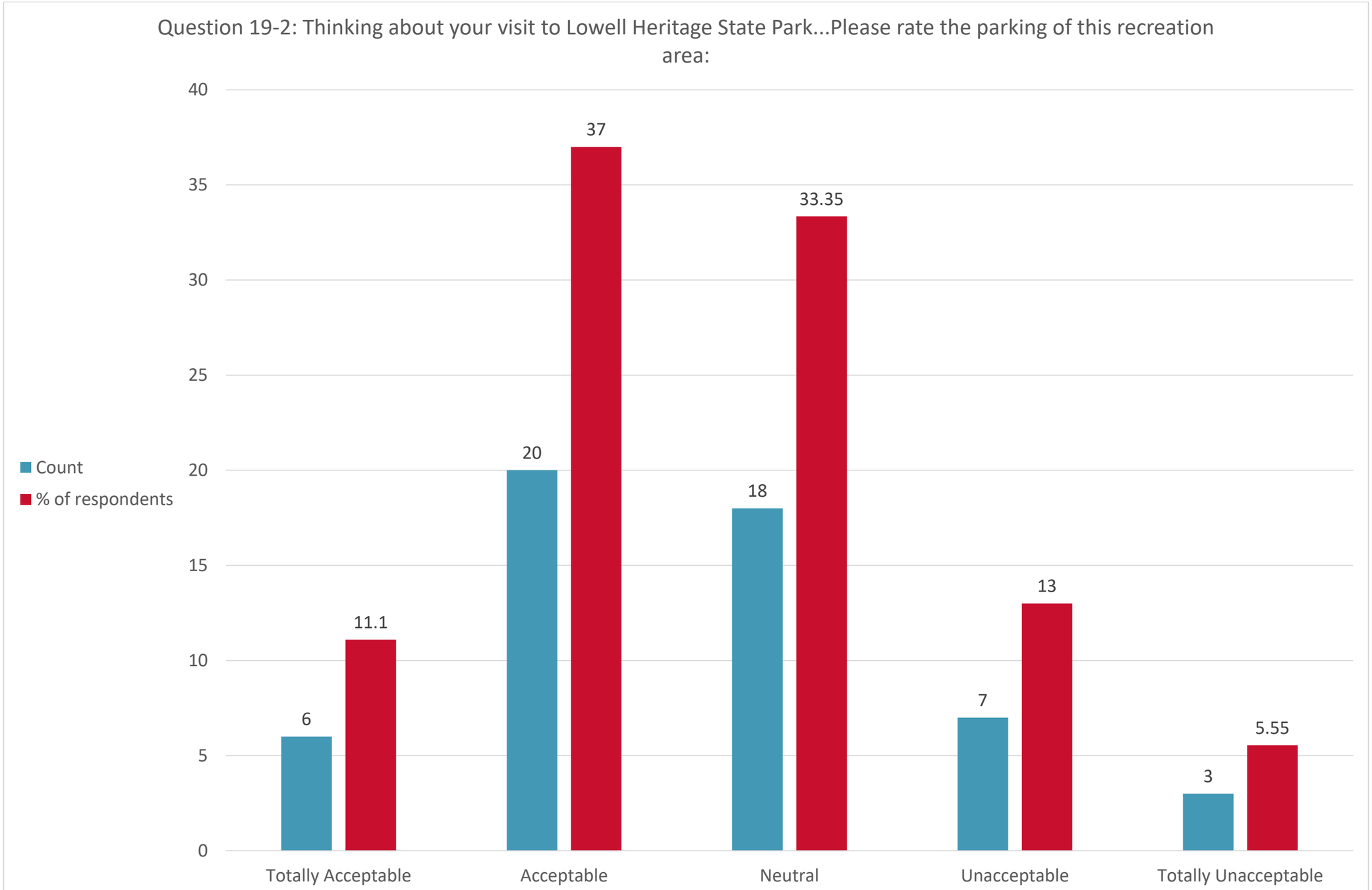

Question 17-3: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Merrimack Canal?
Count
% of respondents
40
35
30
25
20
15
10
5
0
3
3.8
2
2.5
24
30.4
30
38
20
25.3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

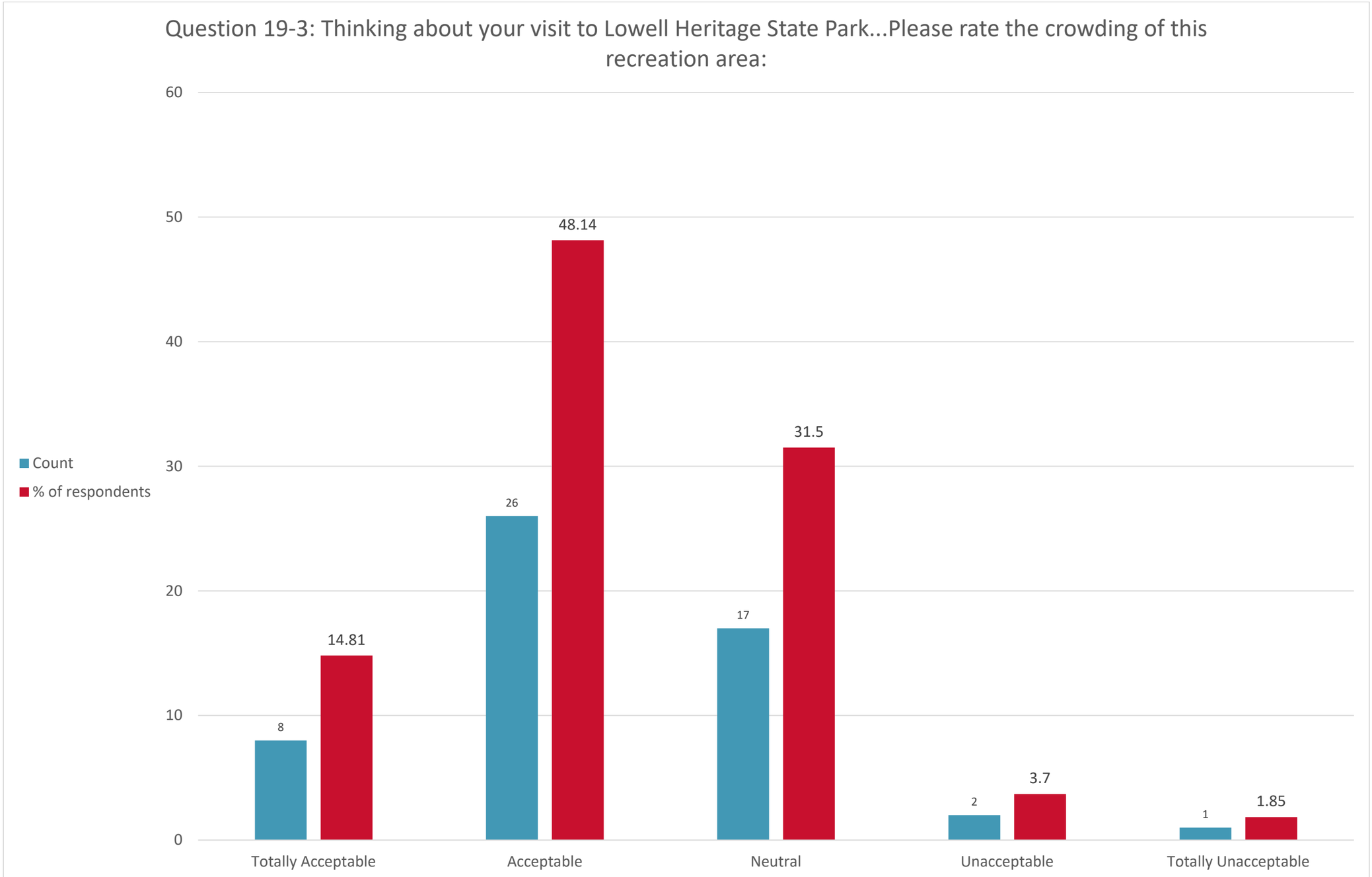

Question 17-4: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Northern Canal?
Count
% of respondents
40
35
30
25
20
15
10
5
0
2
2.6
4
5.2
28
36.8
18
23.7
24
31.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

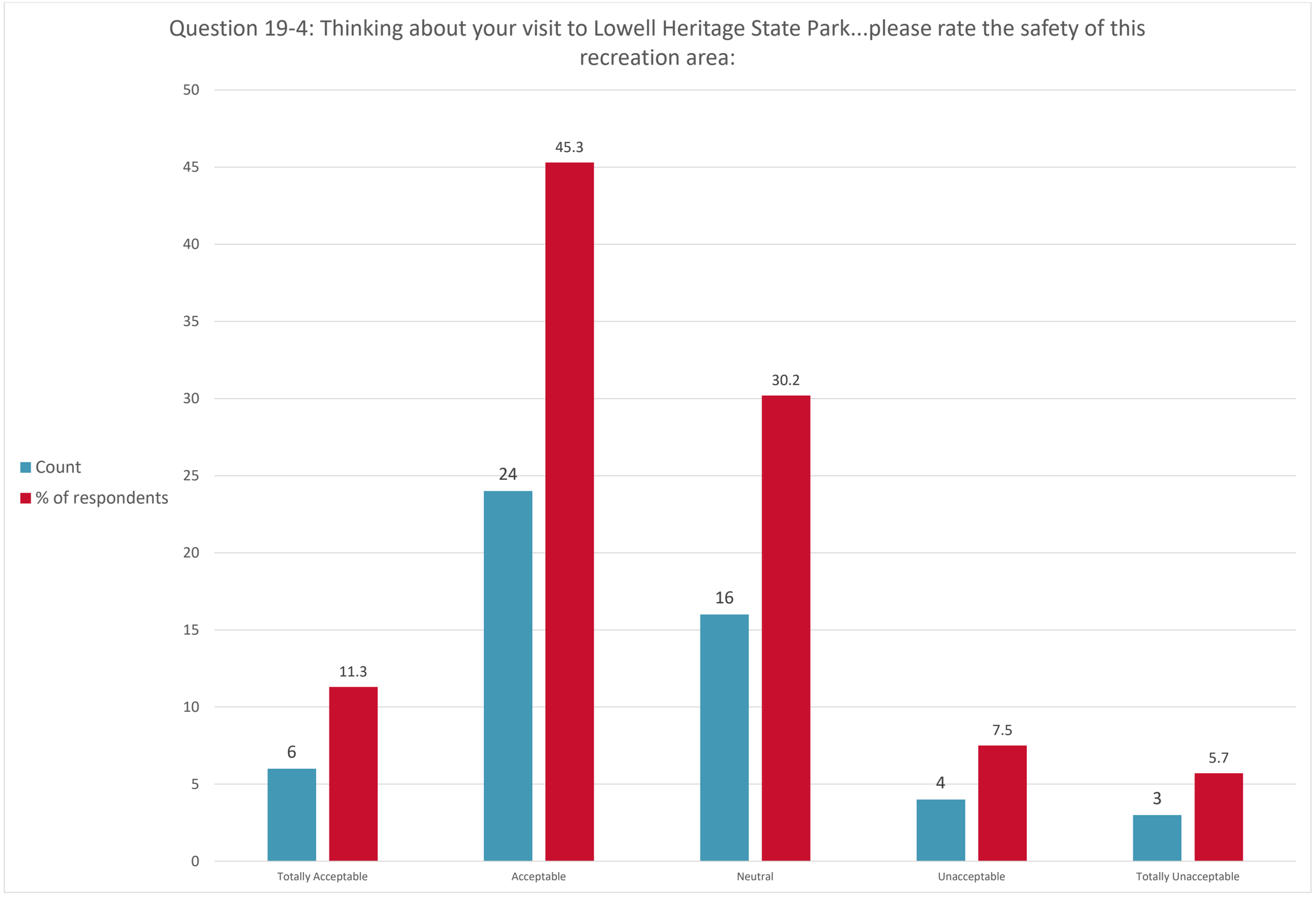

Question 17-5: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Pawtucket Canal?
Count
% of respondents
40
35
30
25
20
15
10
5
0
2
2.55
2
2.55
23
29.5
28
35.9
23
29.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

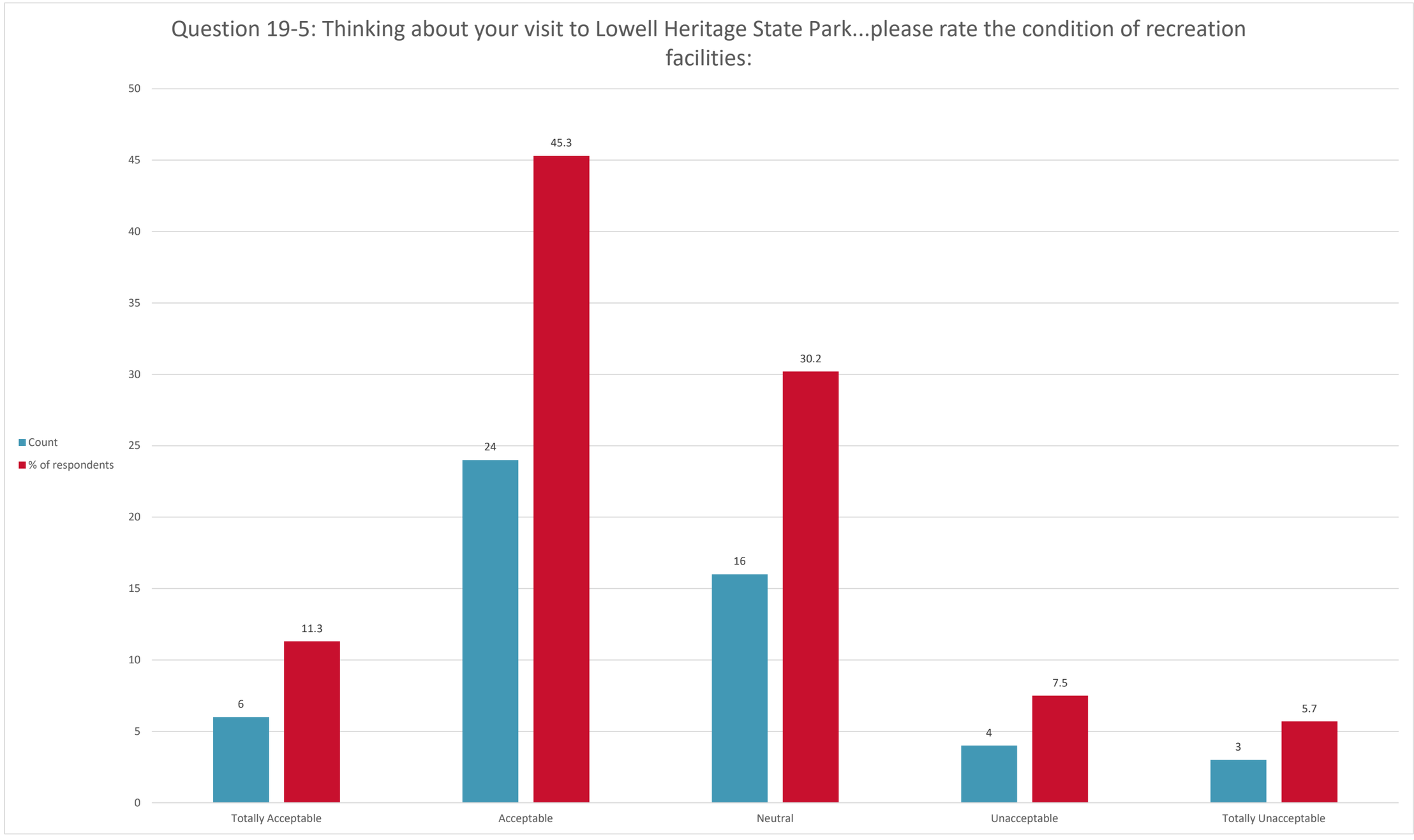

Question 17-6: On your previous visits to the Lowell Project, how would you rate the accumulation of waterborne trash in the Western Canal?
35
30
25
20
15
10
5
0
Count
% of respondents
2
2.6
3
3.908
24
31.164
24
31.164
24
31.164
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

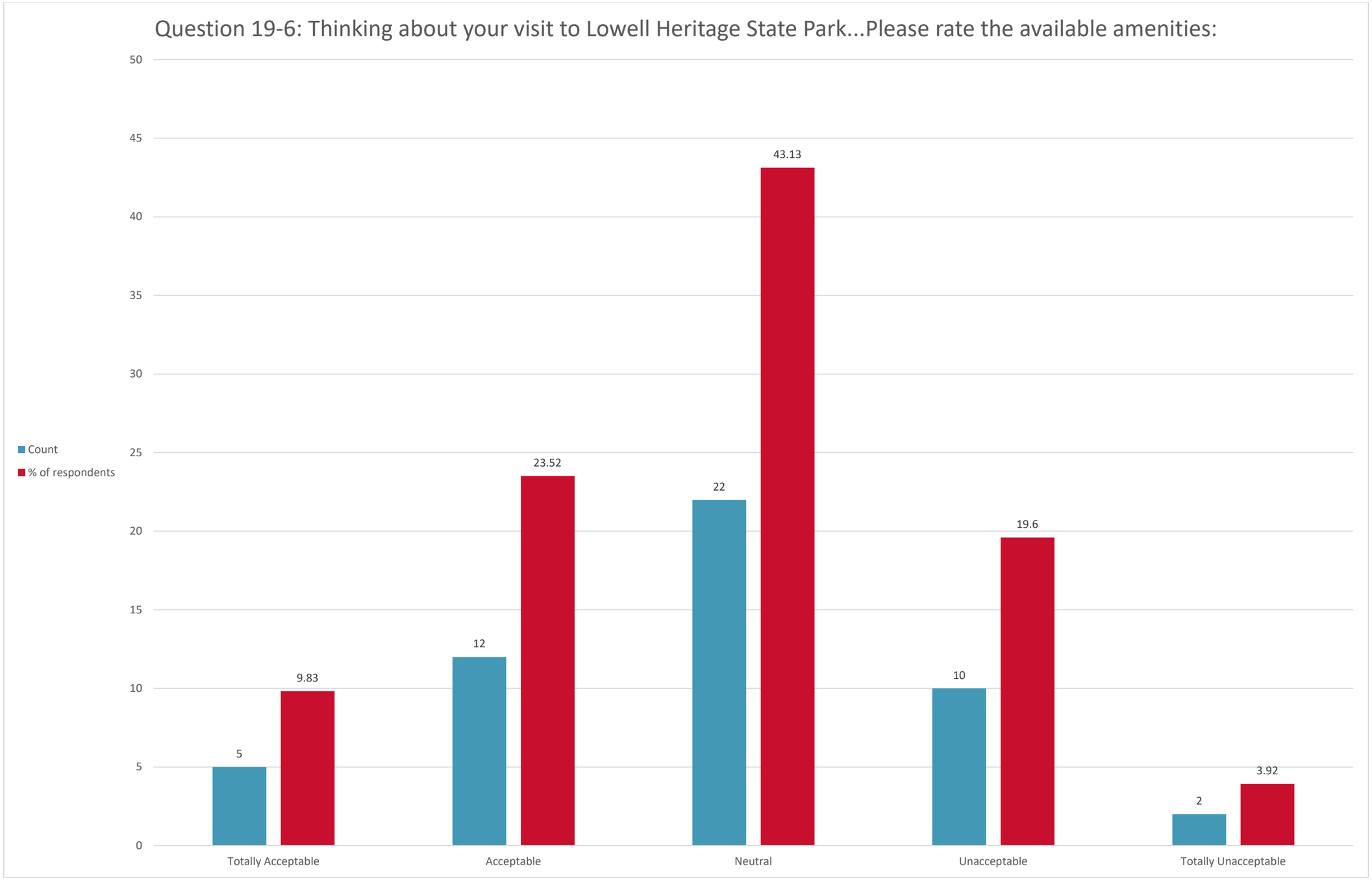

Question 19-1: Thinking about your visit to Lowell Heritage State Park...Please rate the accessibility of this recreation area:
60
50
40
30
20
10
0
Count
% of respondents
7
13.5
25
48
13
25
4
7.8
3
5.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

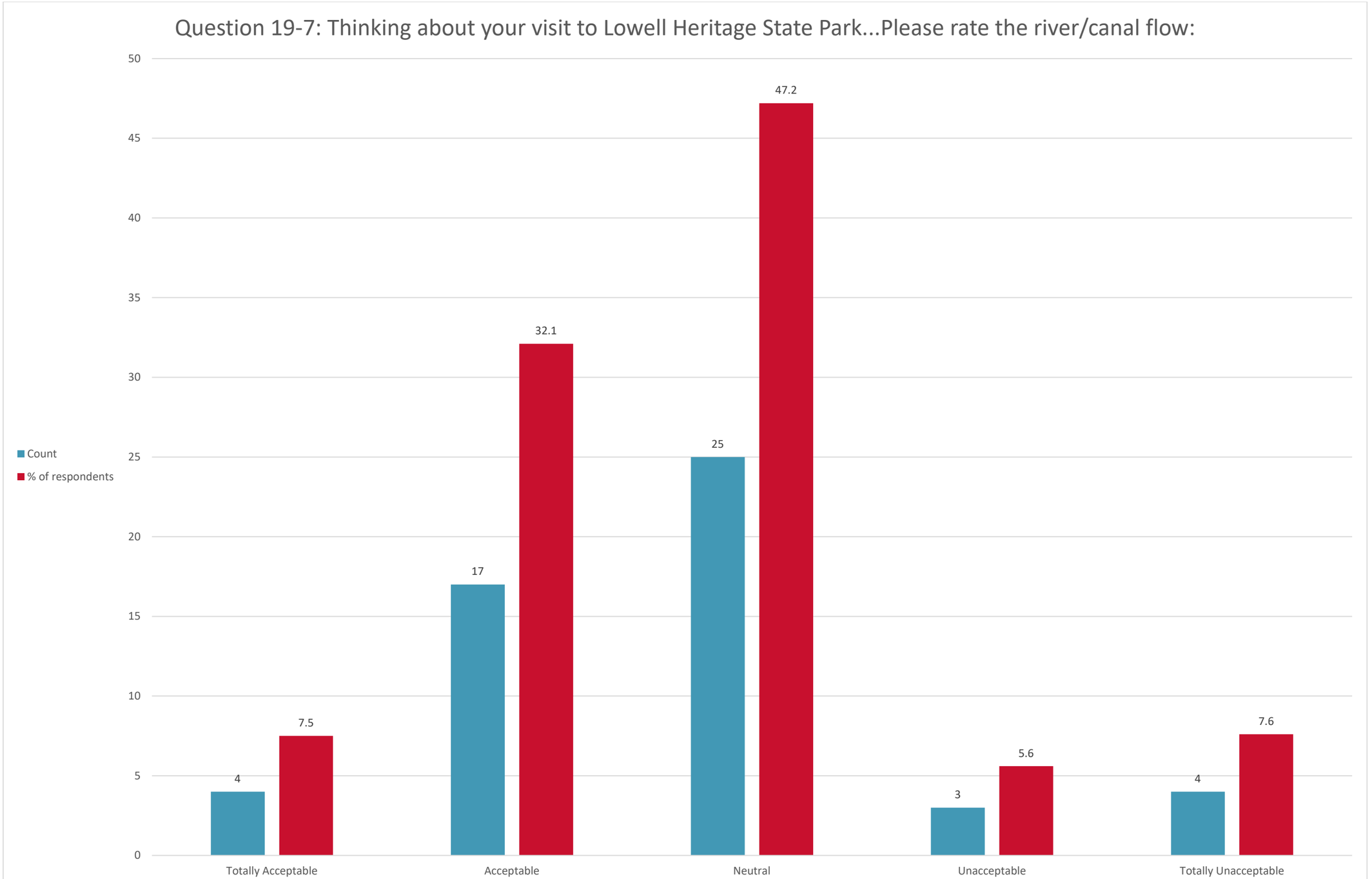

Question 19-2: Thinking about your visit to Lowell Heritage State Park...Please rate the parking of this recreation area:
Count
% of respondents
40
35
30
25
20
15
10
5
0
6
11.1
20
37
18
33.35
7
13
3
5.55
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

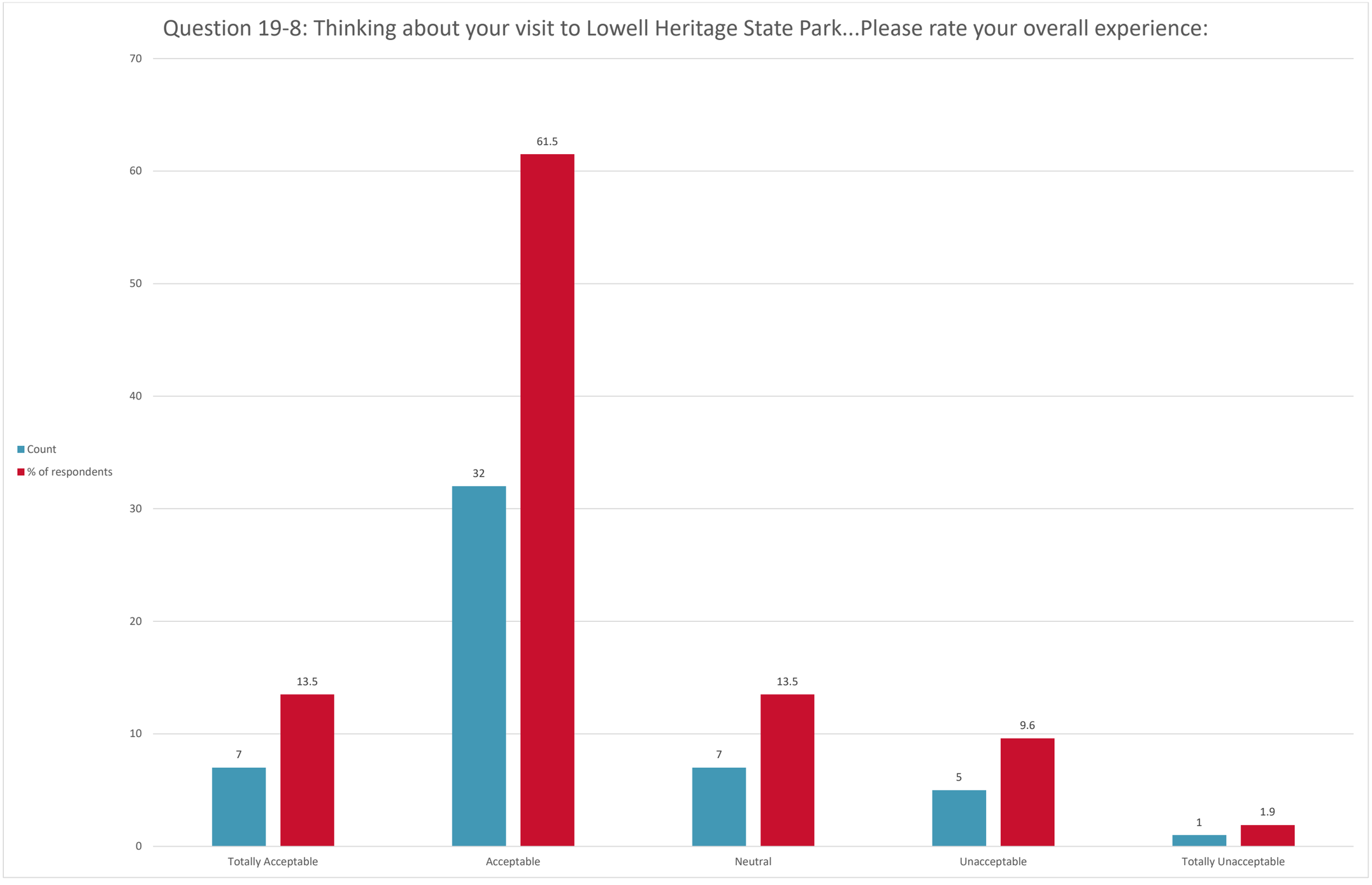

Question 19-3: Thinking about your visit to Lowell Heritage State Park...Please rate the crowding of this recreation area:
Count
% of respondents
60
50
40
30
20
10
0
8
14.81
26
48.14
17
31.5
2
3.7
1
1.85
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

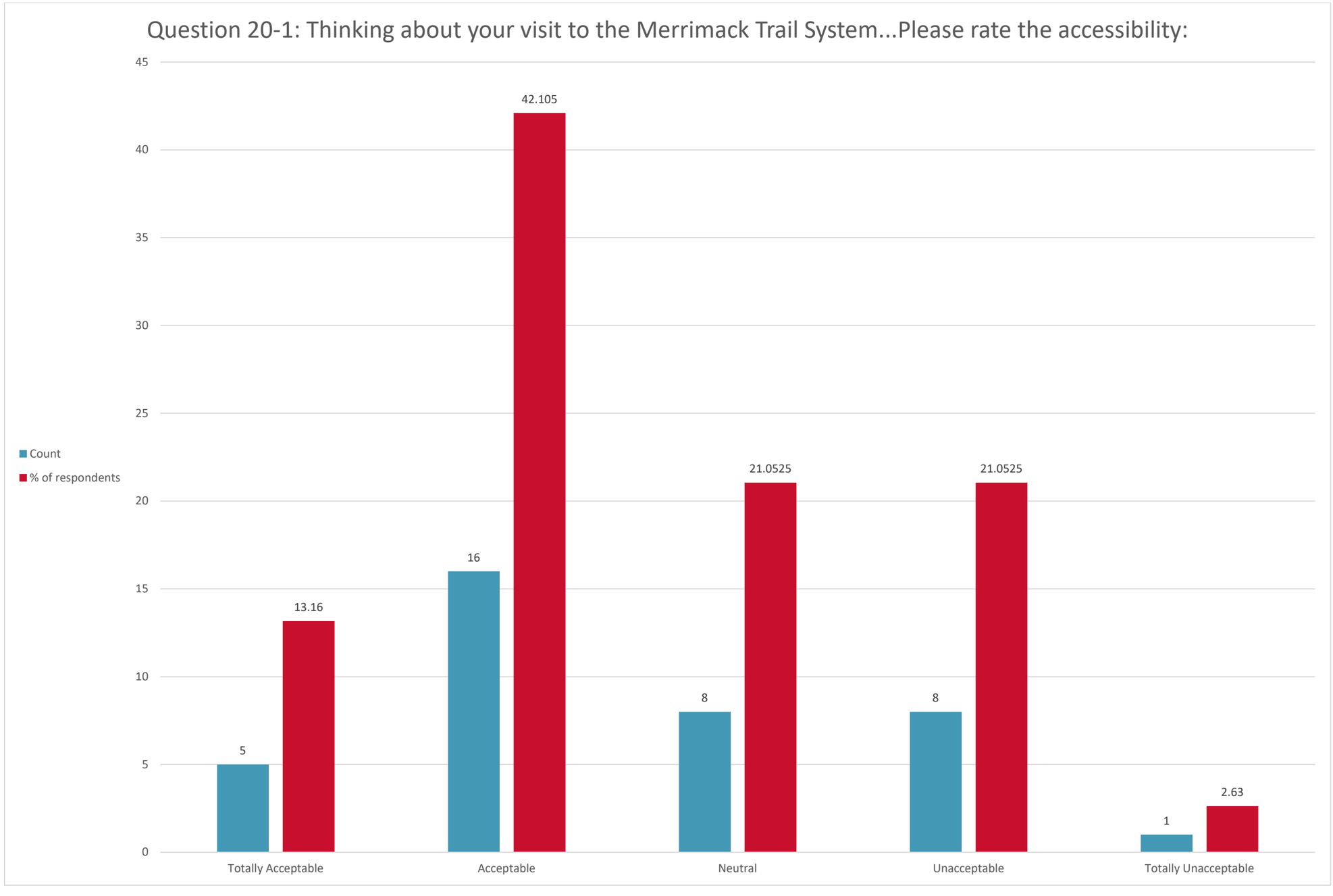

Question 19-4: Thinking about your visit to Lowell Heritage State Park...please rate the safety of this recreation area:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
45.3
30.2
24
16
11.3
6
7.5
4
5.7
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

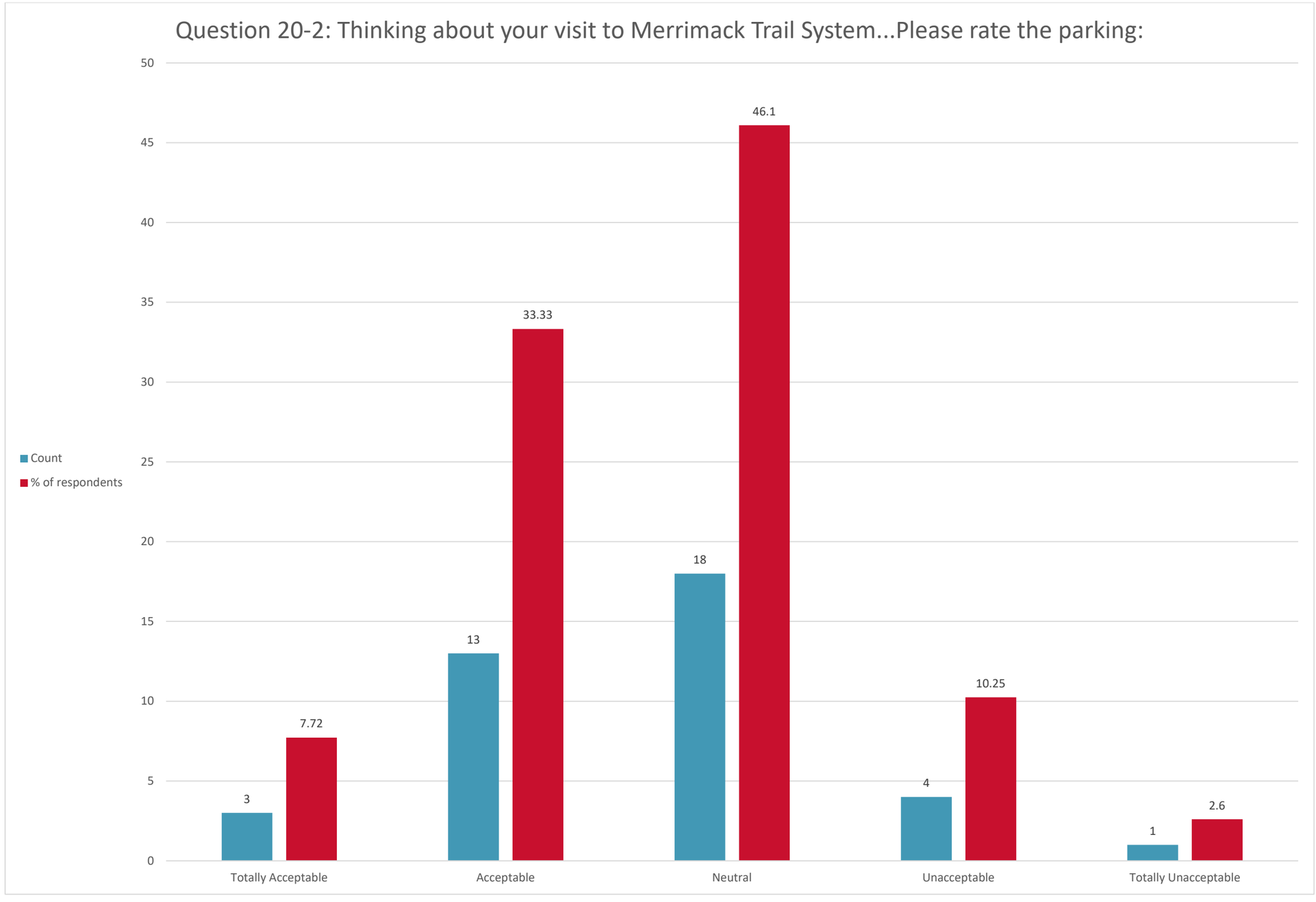

Question 19-5: Thinking about your visit to Lowell Heritage State Park...please rate the condition of recreation facilities:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
6
11.3
24
45.3
16
30.2
4
7.5
3
5.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

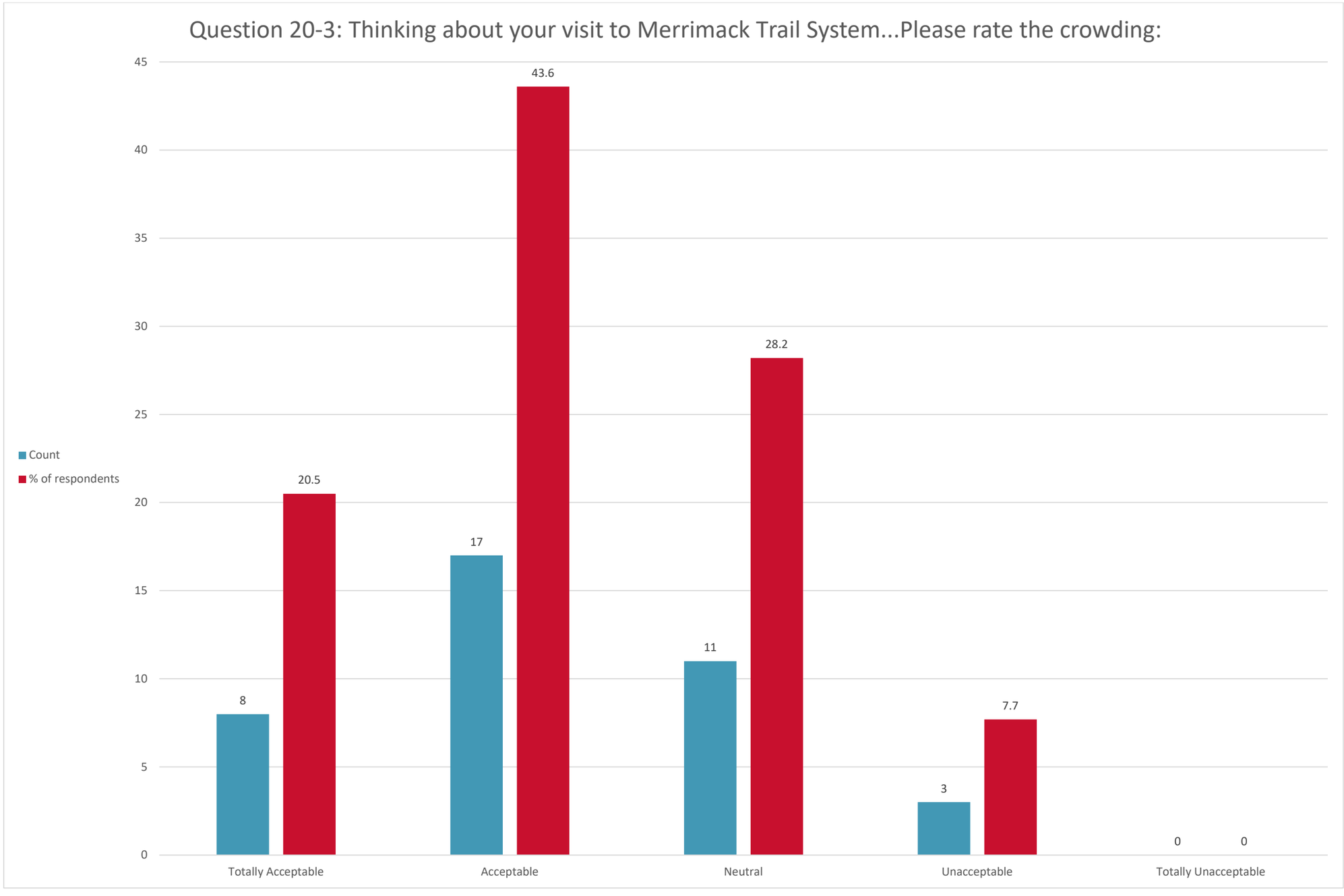

Question 19-6: Thinking about your visit to Lowell Heritage State Park...Please rate the available amenities:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
5
9.83
12
23.52
22
43.13
10
19.6
2
3.92
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

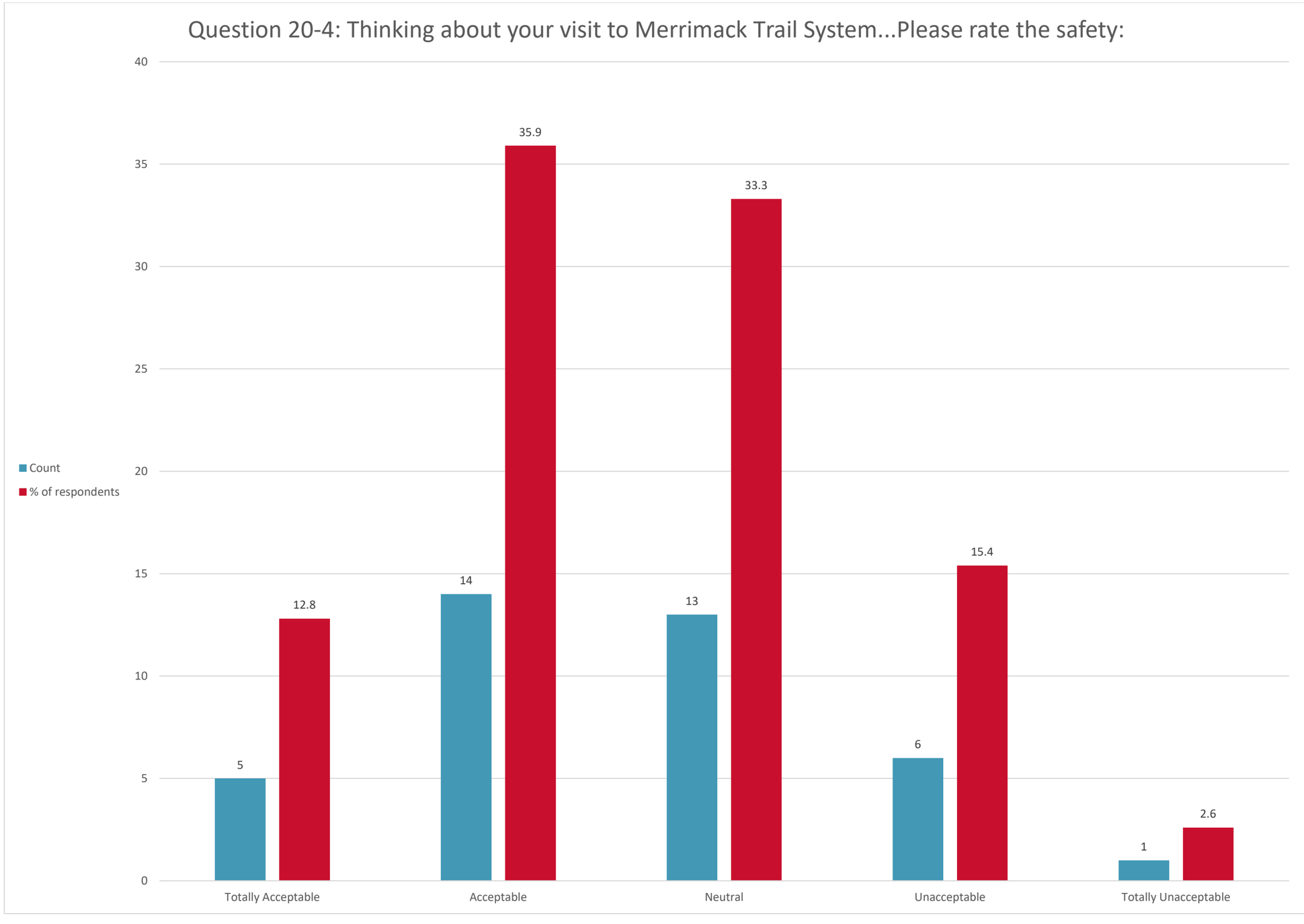

Question 19-7: Thinking about your visit to Lowell Heritage State Park...Please rate the river/canal flow:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
4
7.5
17
32.1
25
47.2
3
5.6
4
7.6
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

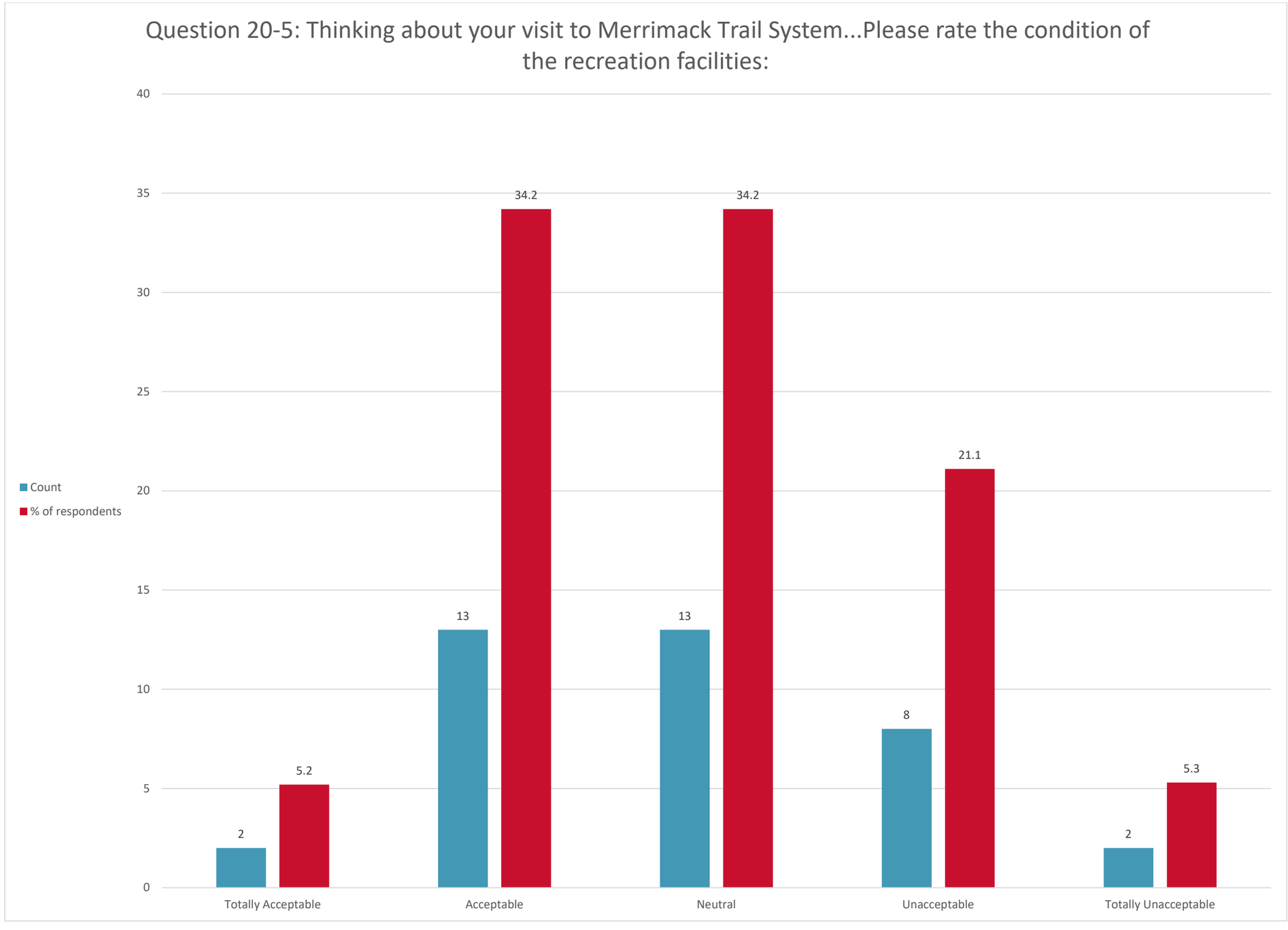

Question 19-8: Thinking about your visit to Lowell Heritage State Park...Please rate your overall experience:
70
60
50
40
30
20
10
0
Count
% of respondents
7
13.5
32
61.5
7
13.5
5
9.6
1
1.9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

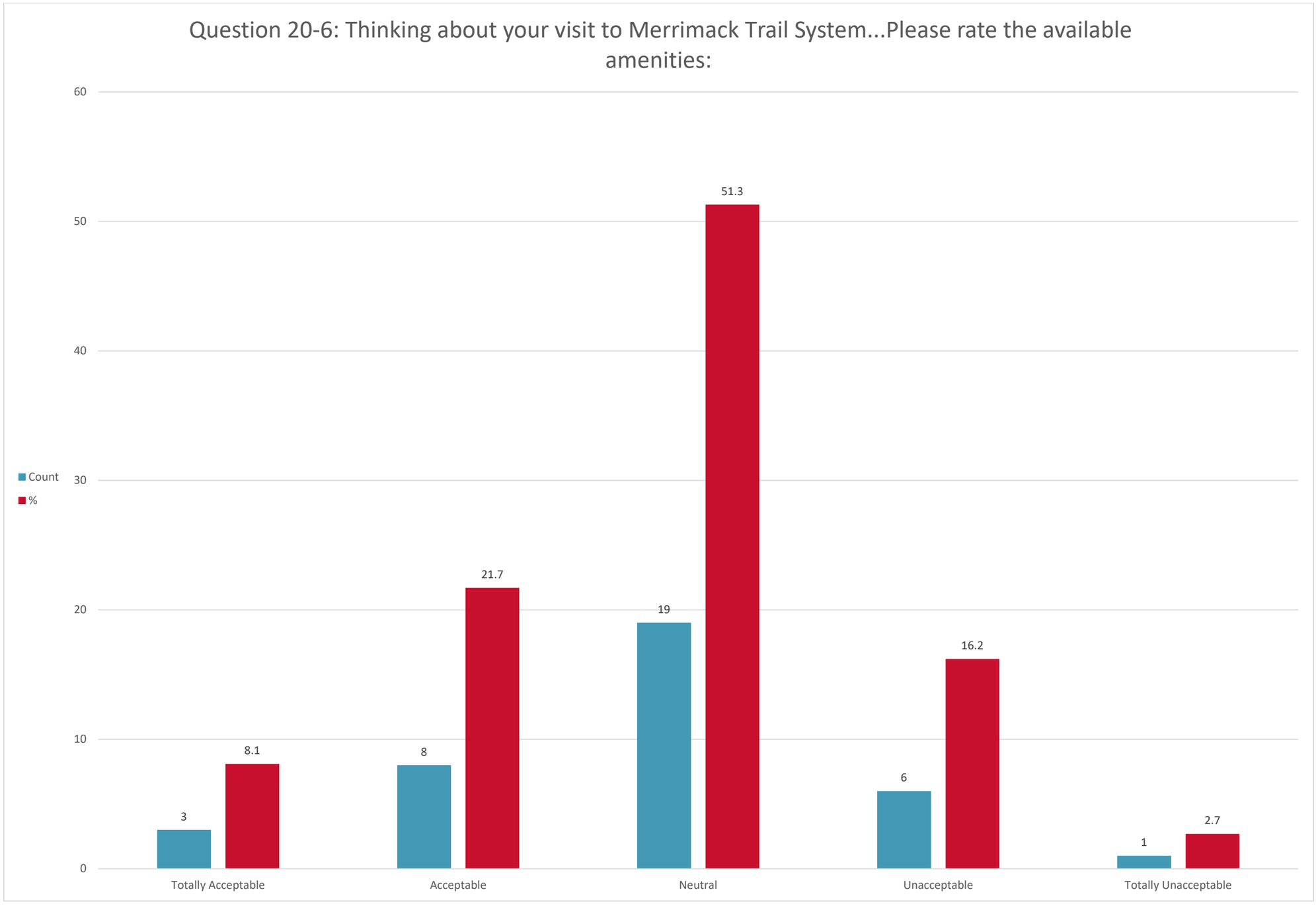

Question 20-1: Thinking about your visit to the Merrimack Trail System...Please rate the accessibility:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
42.105
21.0525
21.0525
13.16
16
8
8
5
1
2.63
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

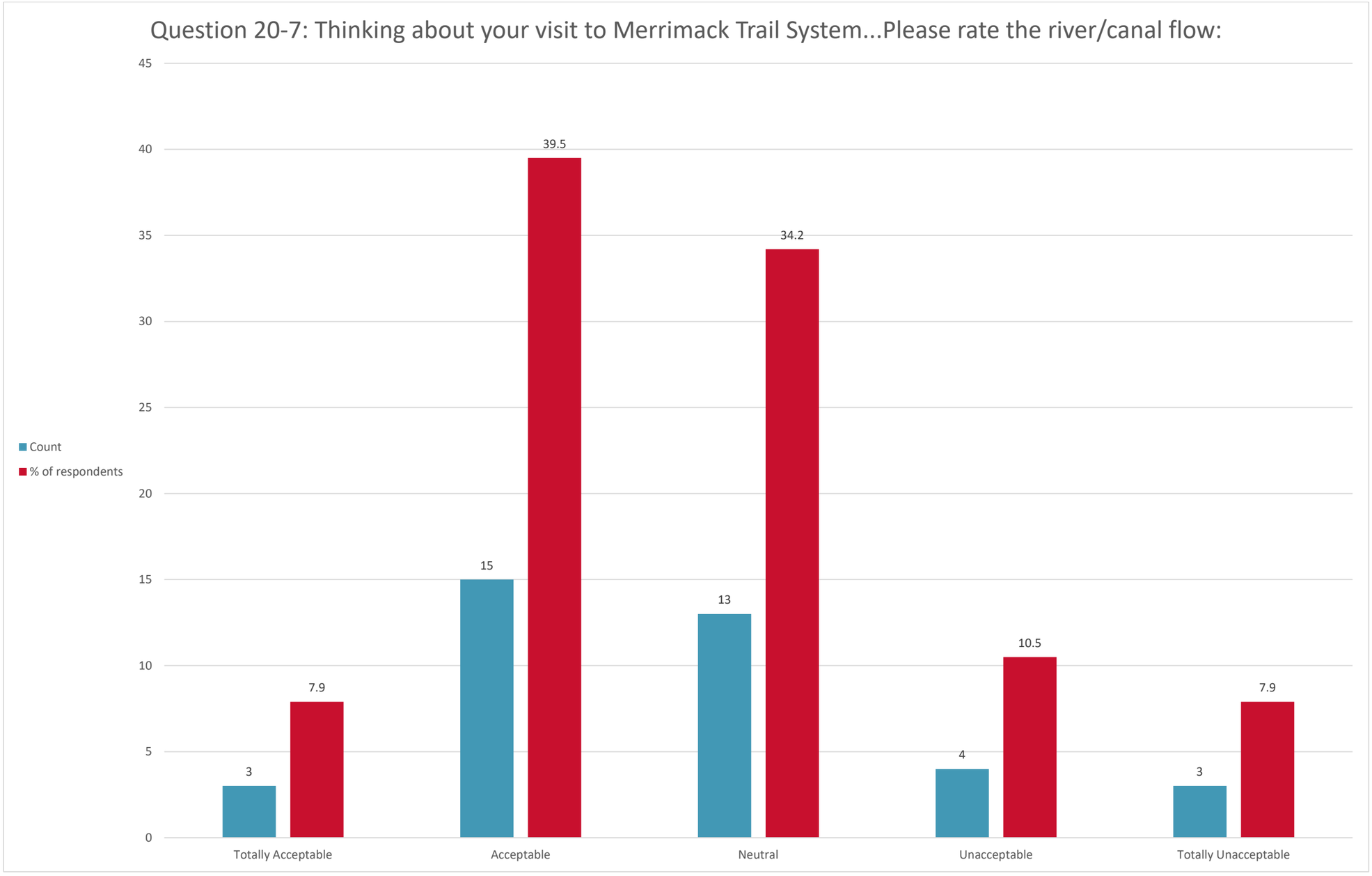

Question 20-2: Thinking about your visit to Merrimack Trail System...Please rate the parking:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
3
7.72
13
33.33
18
46.1
4
10.25
1
2.6
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

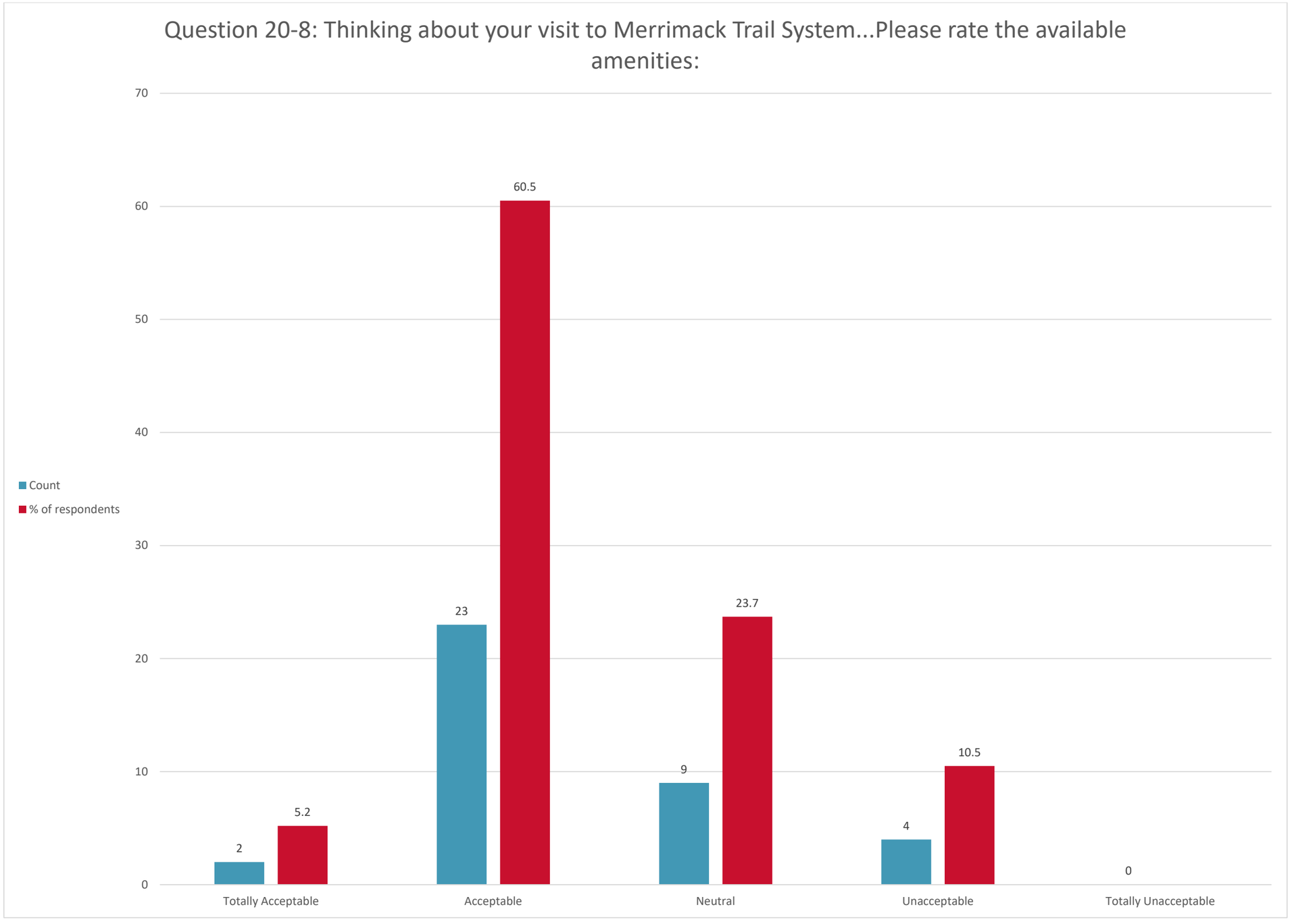

Question 20-3: Thinking about your visit to Merrimack Trail System...Please rate the crowding:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
8
20.5
17
43.6
11
28.2
3
7.7
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

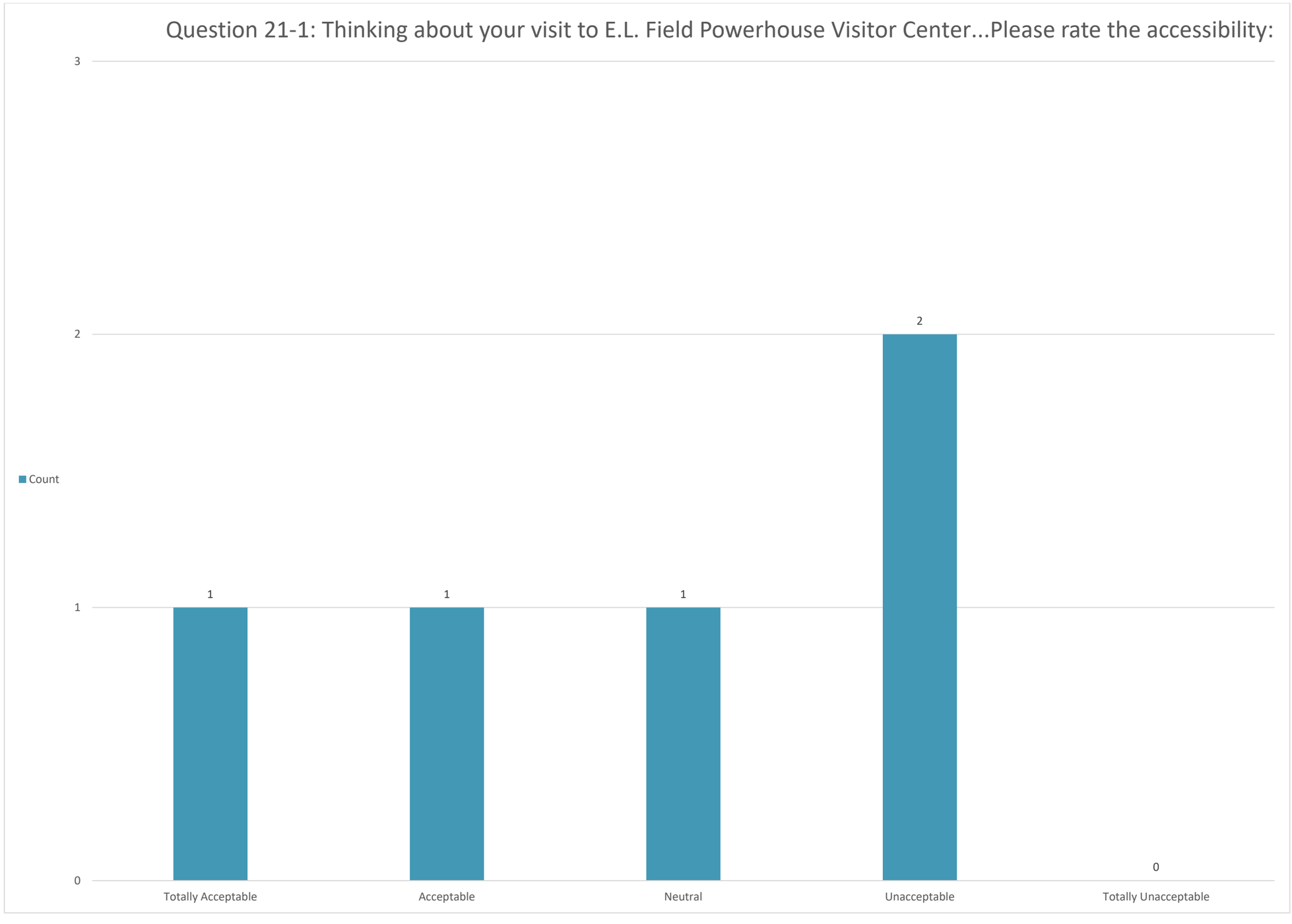

Question 20-4: Thinking about your visit to Merrimack Trail System...Please rate the safety:
Count
% of respondents
40
35
30
25
20
15
10
5
0
5
12.8
14
35.9
13
33.3
6
15.4
1
2.6
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

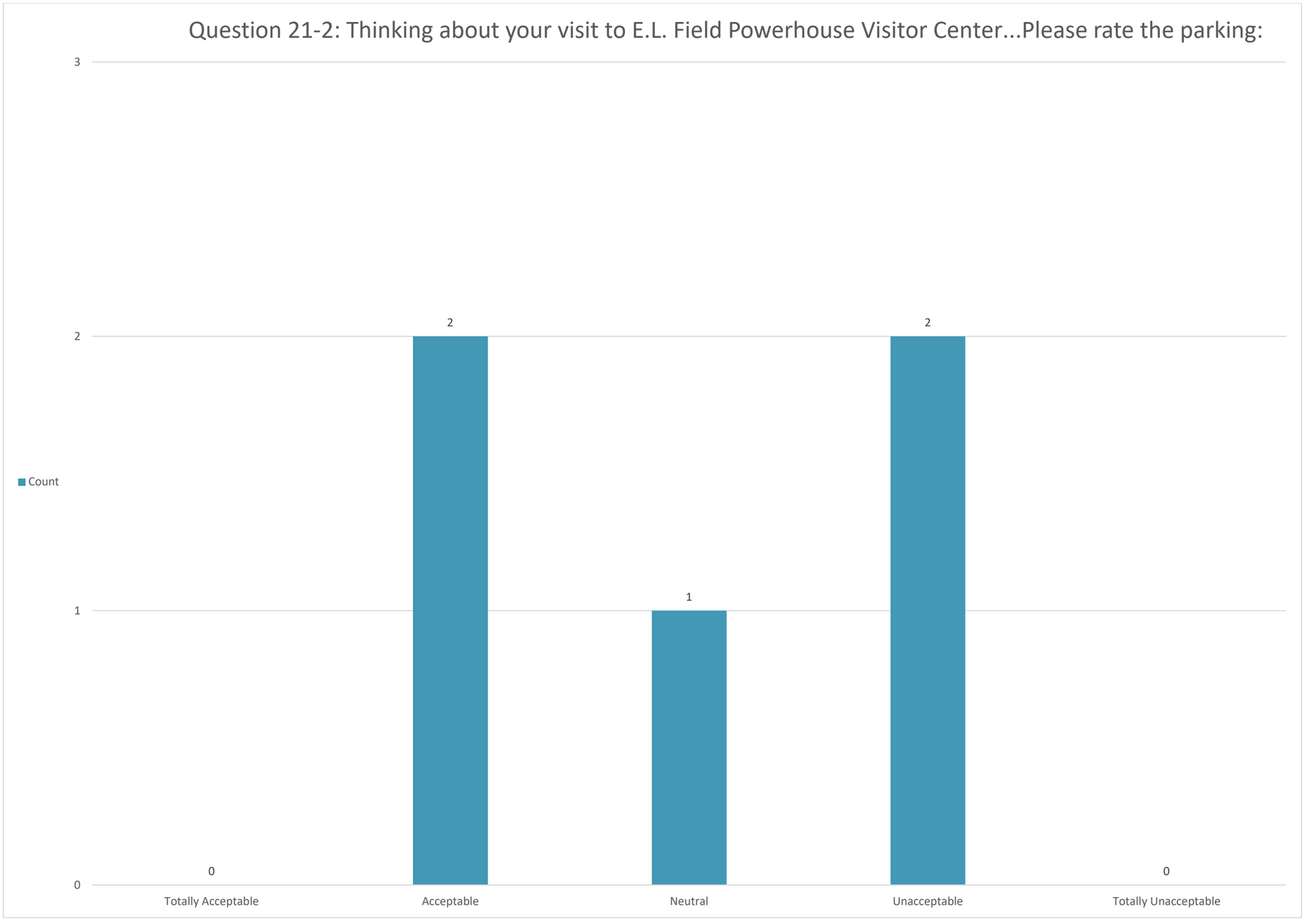

Question 20-5: Thinking about your visit to Merrimack Trail System...Please rate the condition of the recreation facilities:
Count
% of respondents
40
35
30
25
20
15
10
5
0
34.2
34.2
21.1
13
13
8
5.2
5.3
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

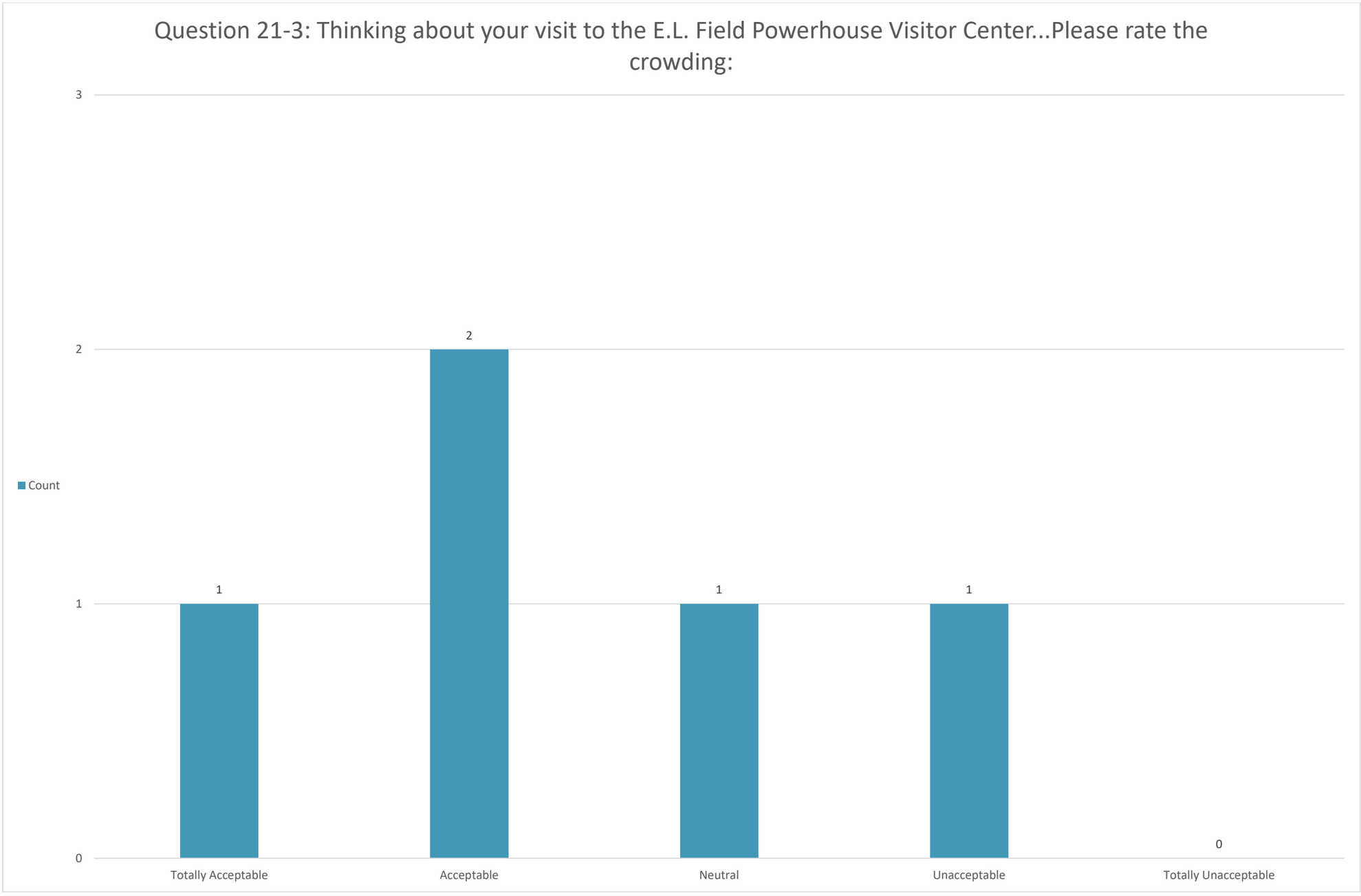

Question 20-6: Thinking about your visit to Merrimack Trail System...Please rate the available amenities:
Count
%
60
50
40
30
20
10
0
3
8.1
8
21.7
19
51.3
6
16.2
1
2.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

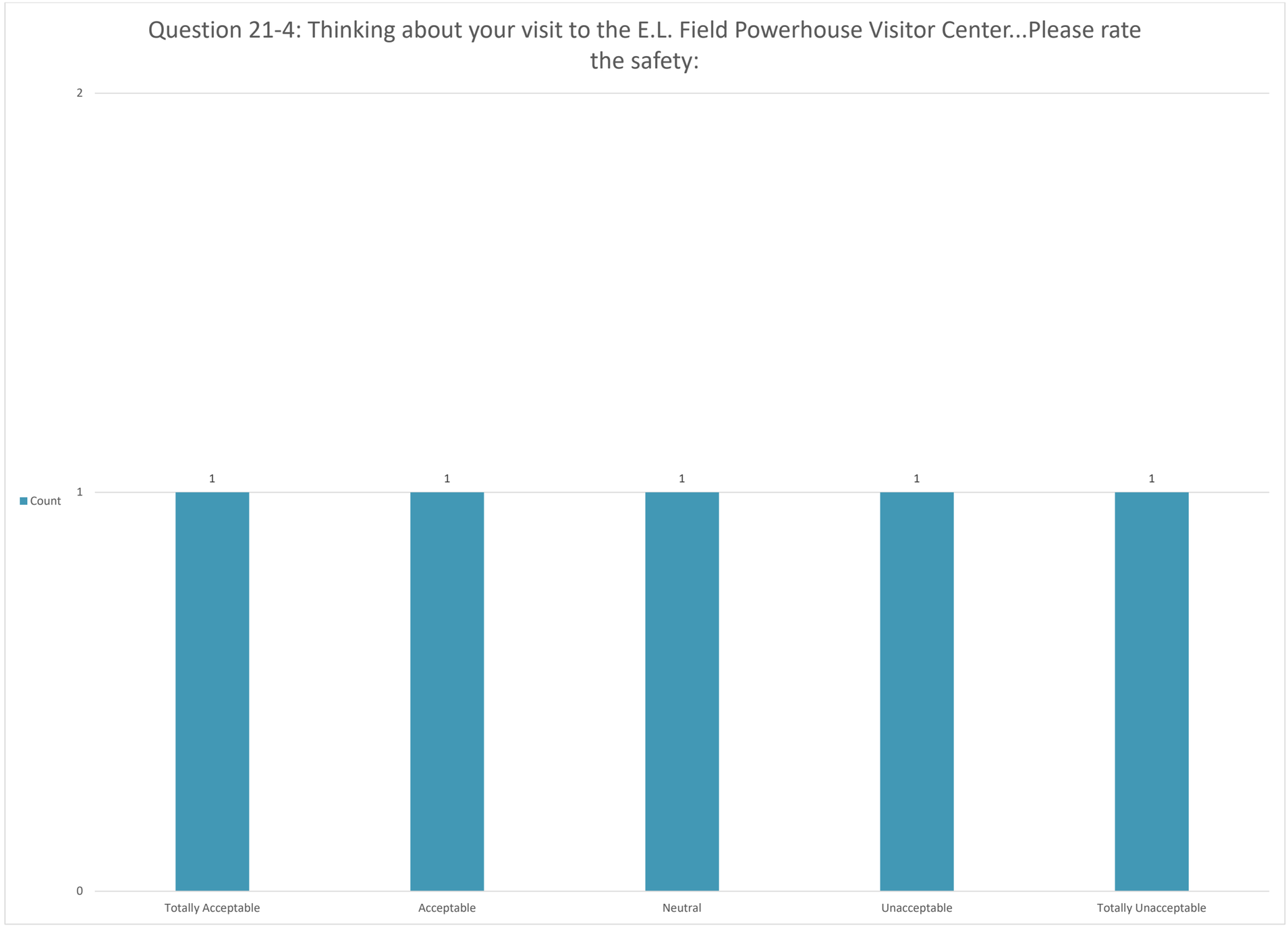

Question 20-7: Thinking about your visit to Merrimack Trail System...Please rate the river/canal flow:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
39.5
34.2
15
13
10.5
7.9
7.9
4
3
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

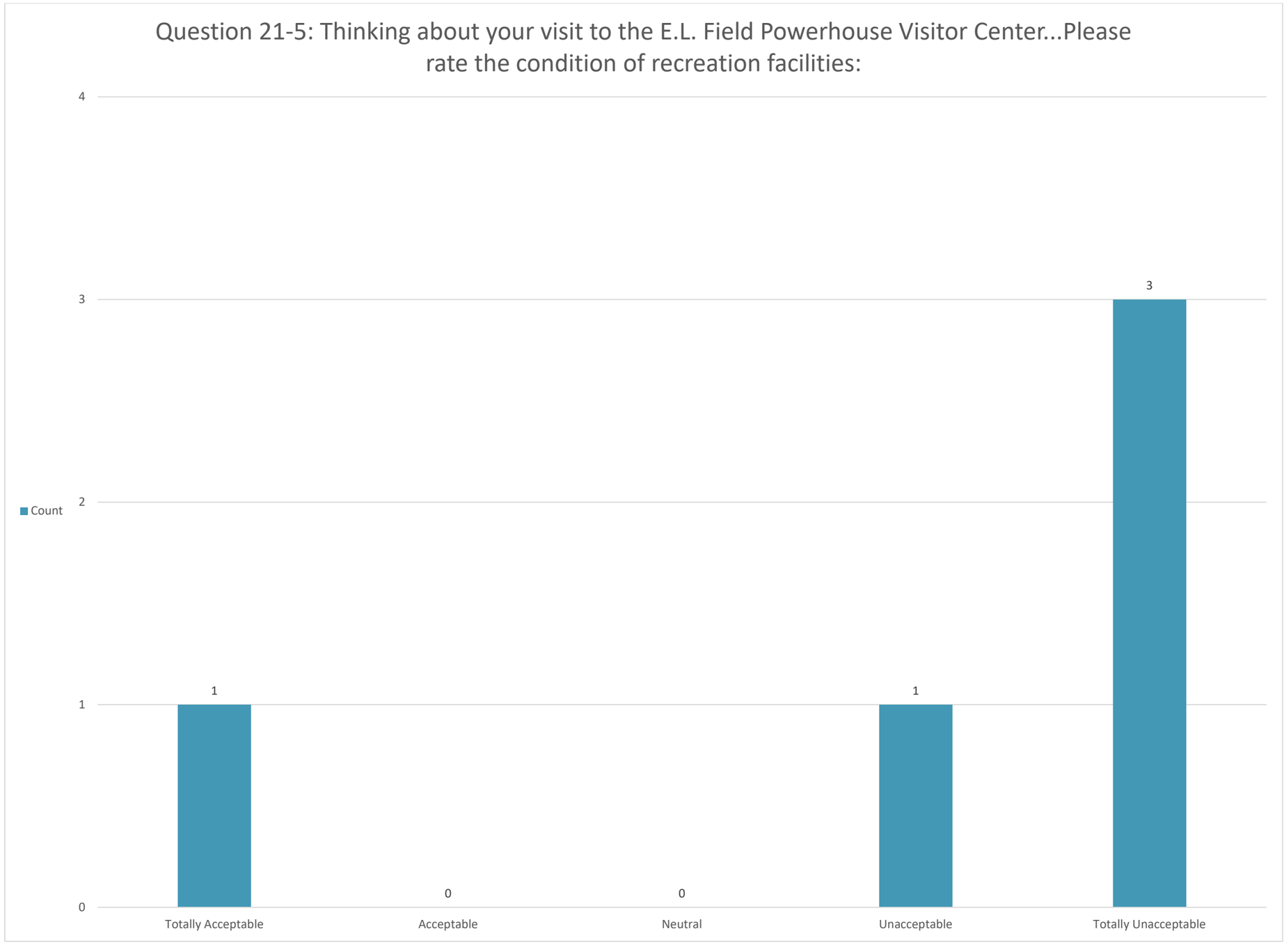

Question 20-8: Thinking about your visit to Merrimack Trail System...Please rate the available amenities:
70
60
50
40
30
20
10
0
Count
% of respondents
2
5.2
23
60.5
9
23.7
4
10.5
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

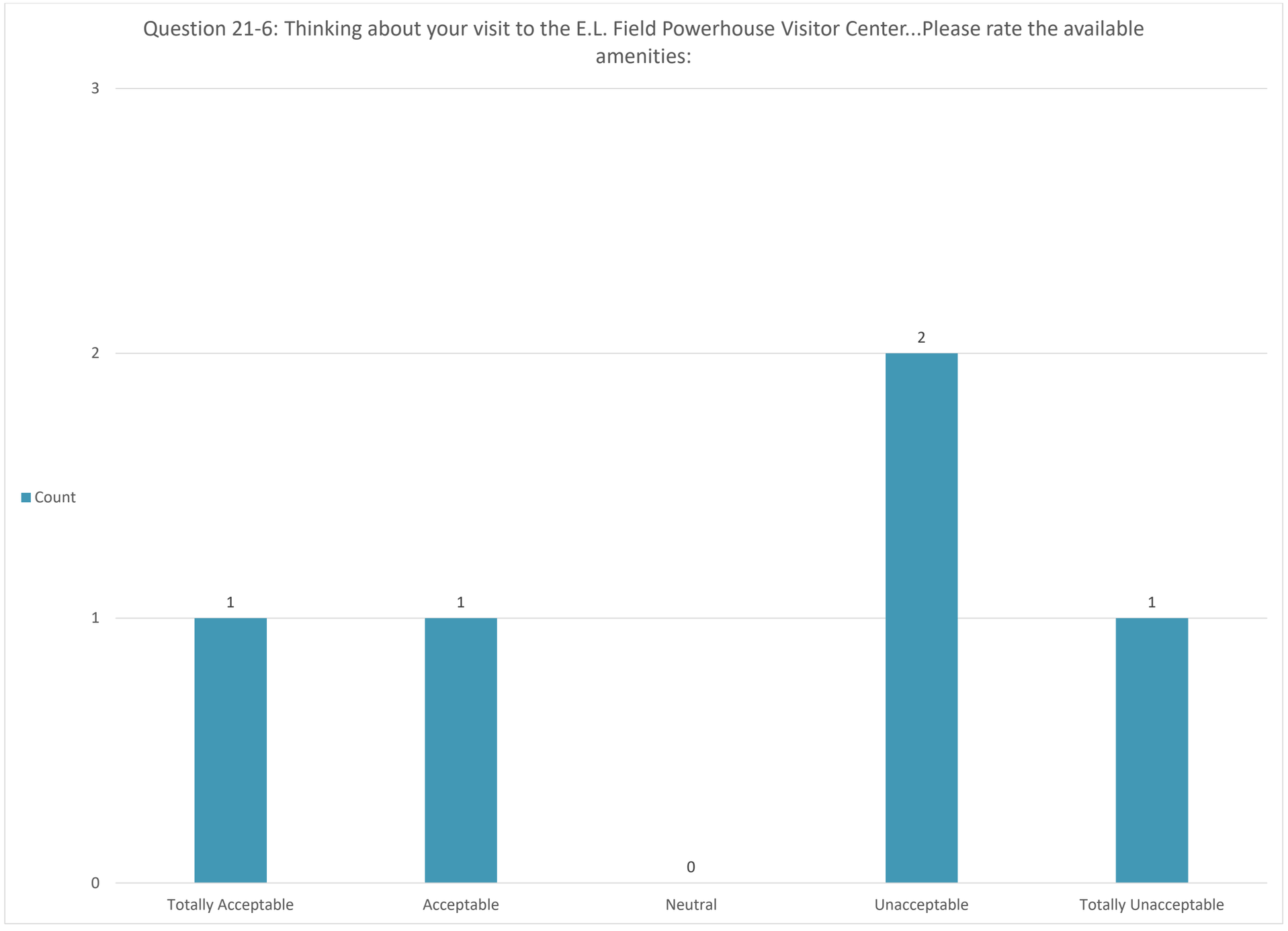

Question 21-1: Thinking about your visit to E.L. Field Powerhouse Visitor Center...Please rate the accessibility:
3
2
1
0
Count
1
1
1
2
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

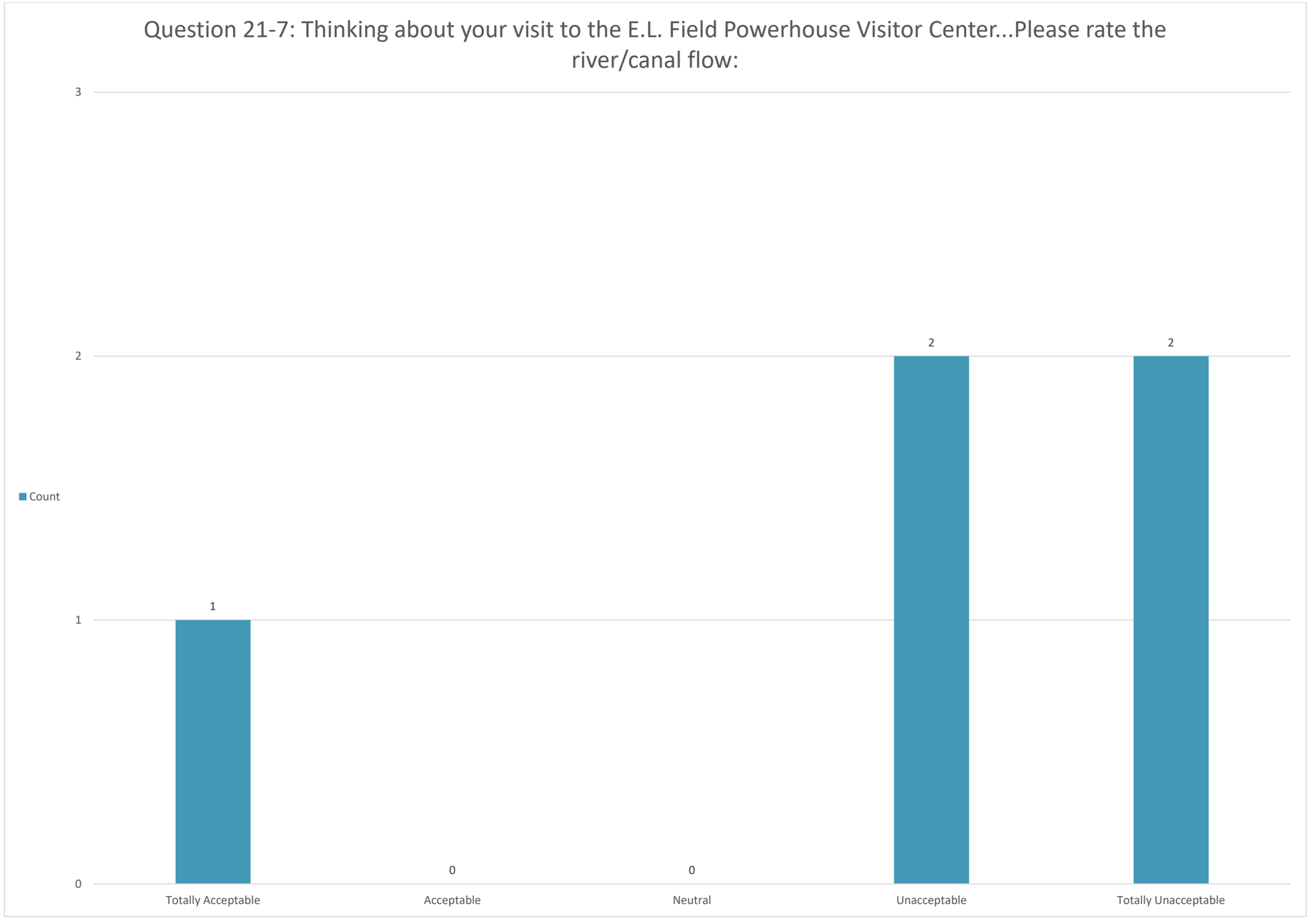

Question 21-2: Thinking about your visit to E.L. Field Powerhouse Visitor Center...Please rate the parking:
3
2
1
0
Count
0
2
1
2
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

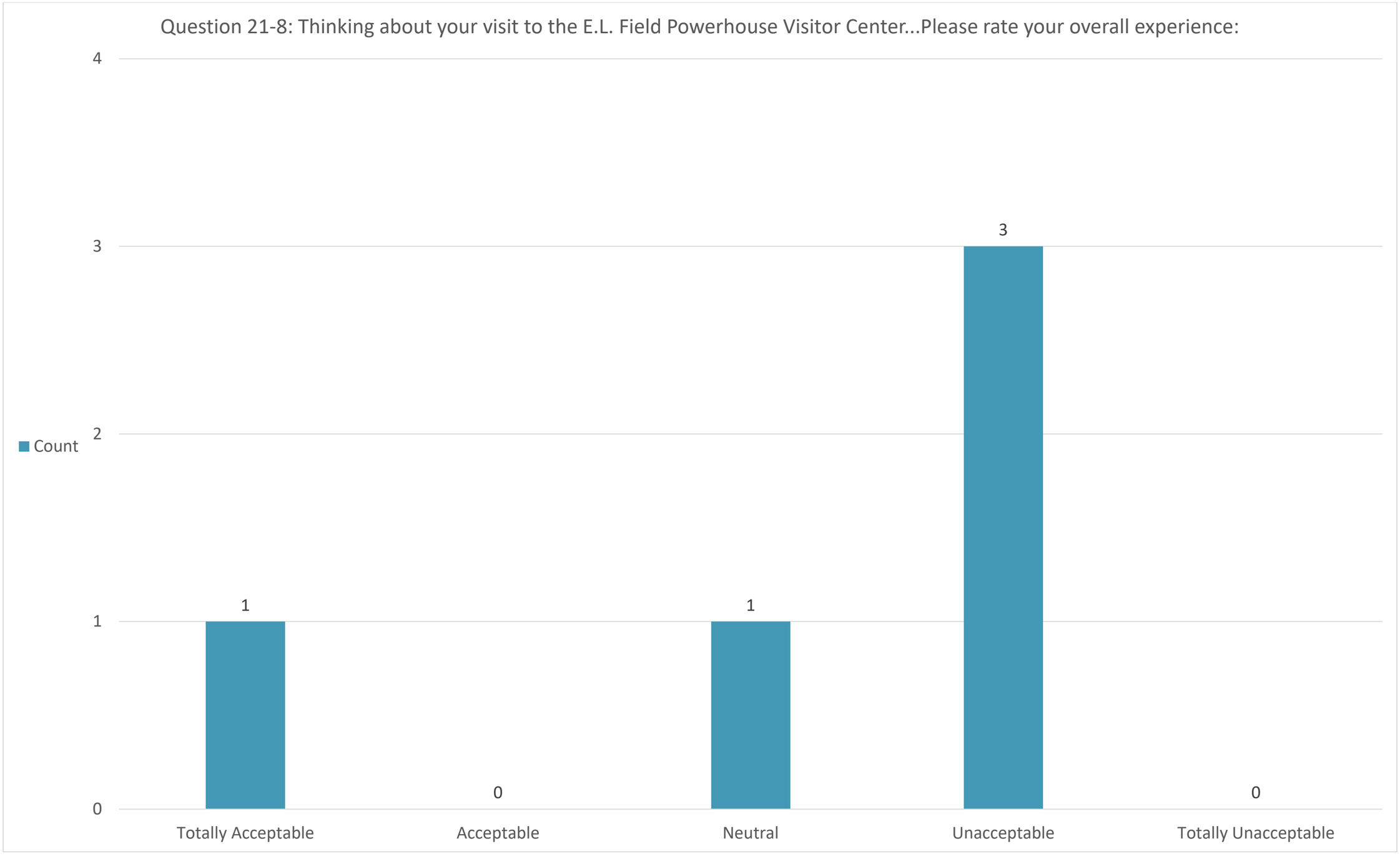

Question 21-3: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate the crowding:
3
2
1
0
Count
1
2
1
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

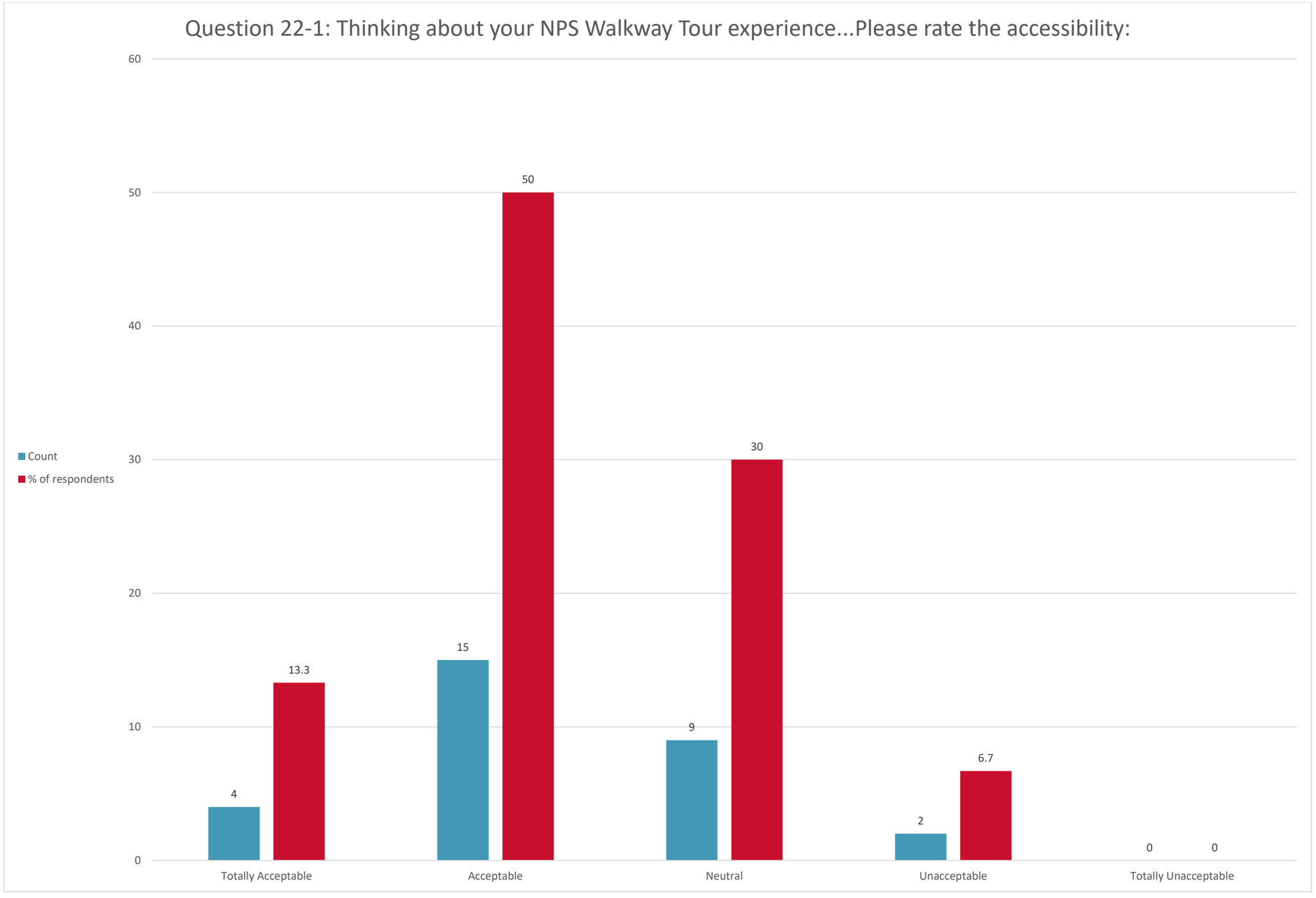

Question 21-4: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate the safety:
2
1
0
Count
1
1
1
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

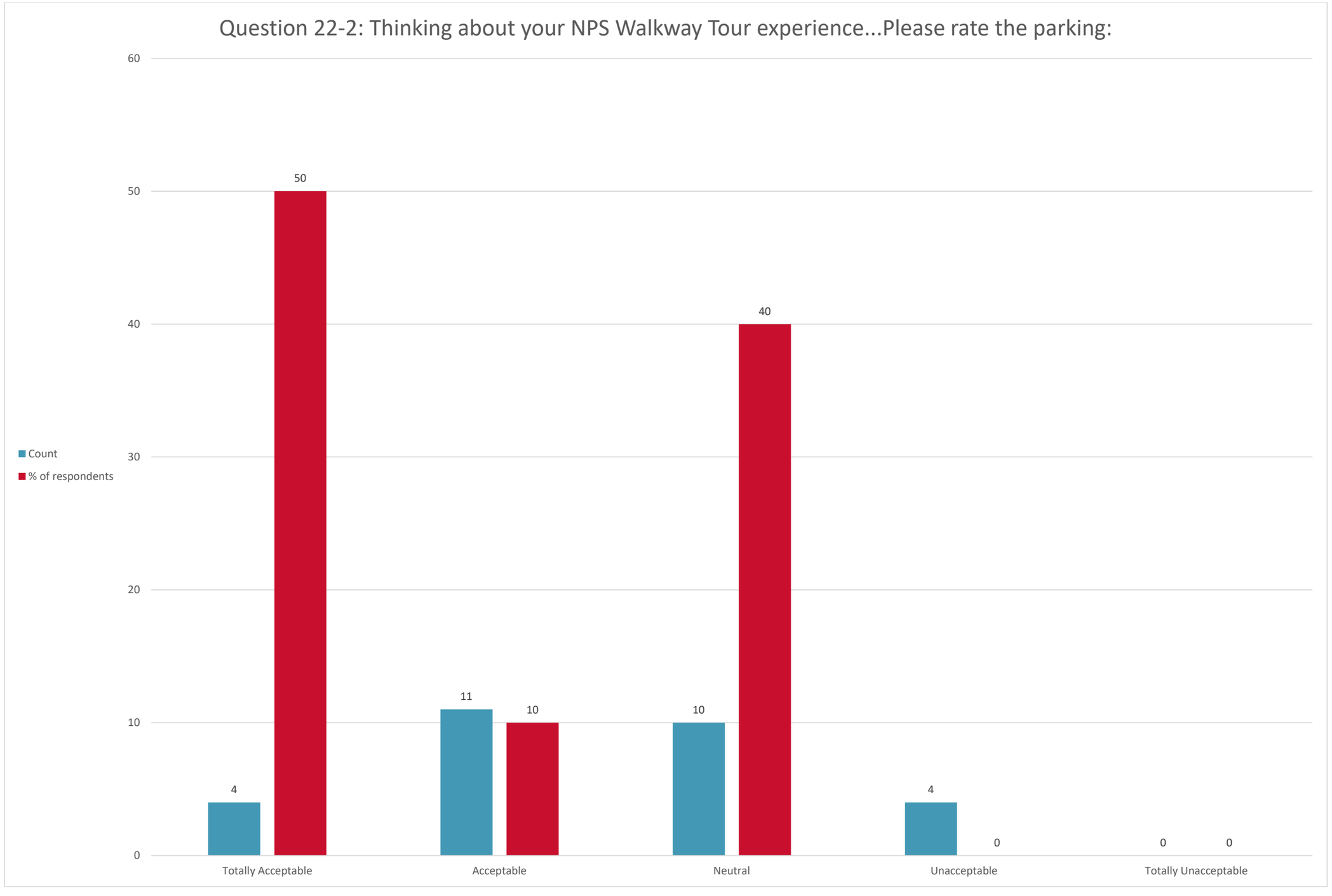

Question 21-5: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate the condition of recreation facilities:
Count
4
3
2
1
0
1
0
0
1
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

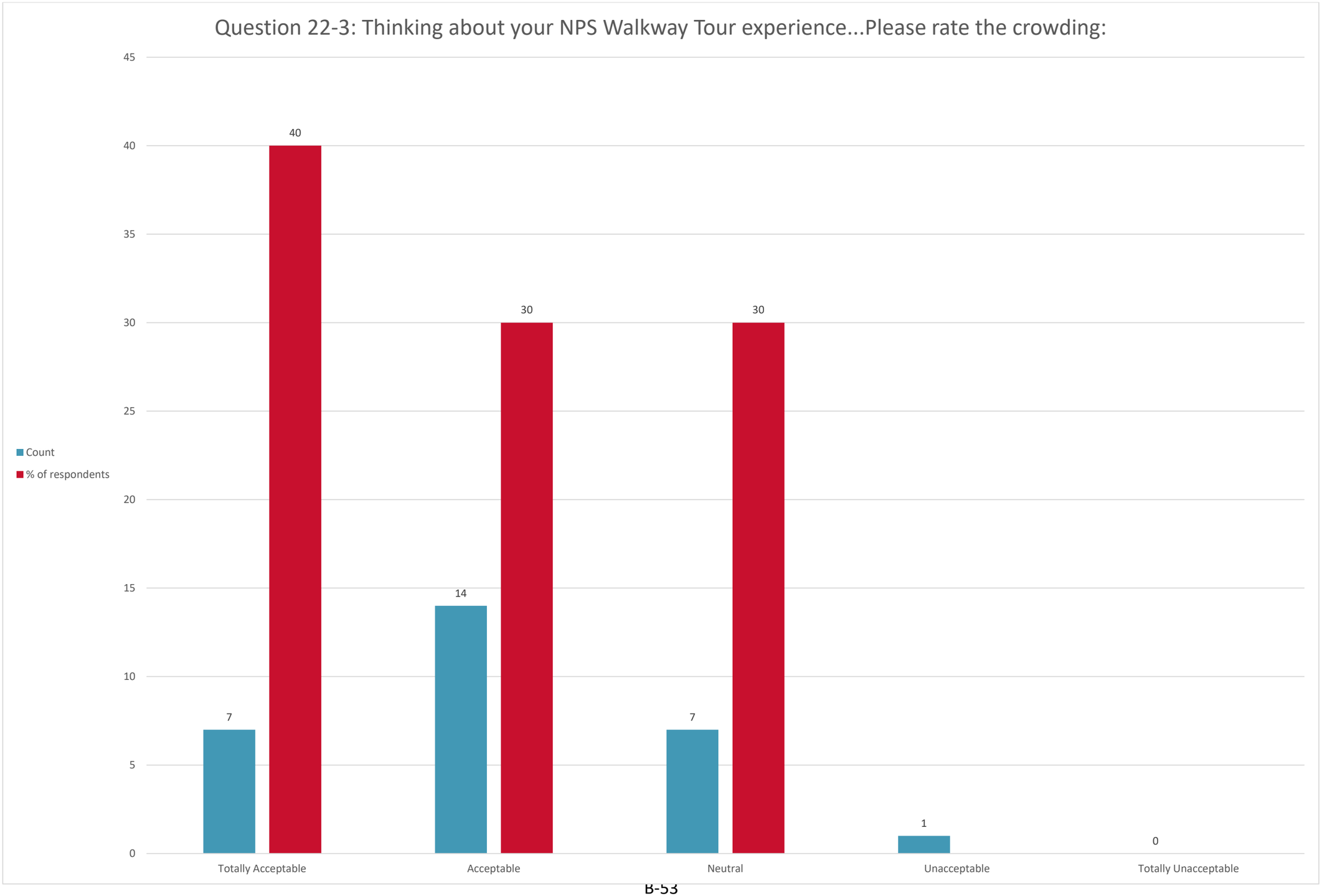

Question 21-6: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate the available amenities:
3
2
1
0
Count
1
1
0
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

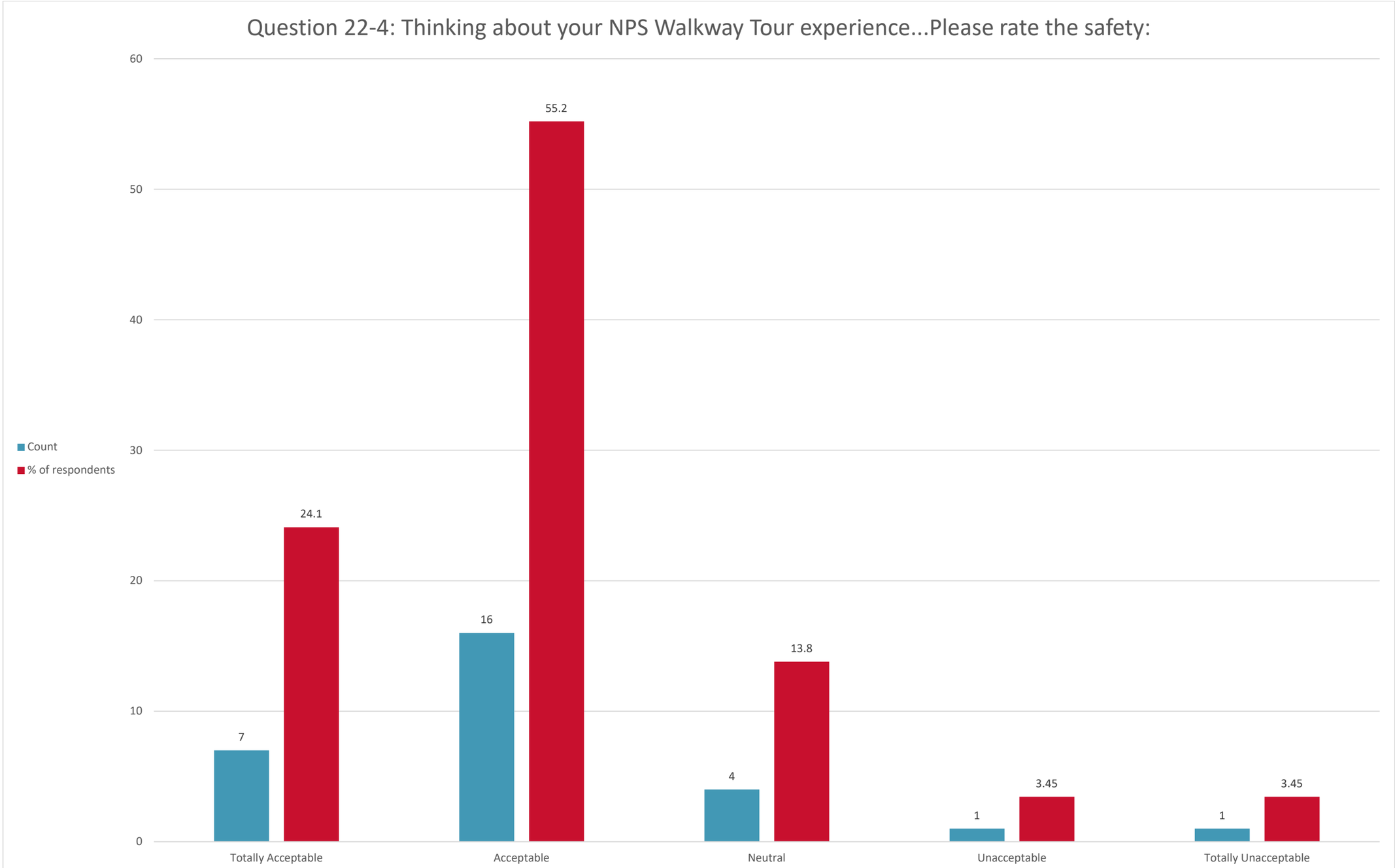

Question 21-7: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate the river/canal flow:
3
2
1
0
Count
1
0
0
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

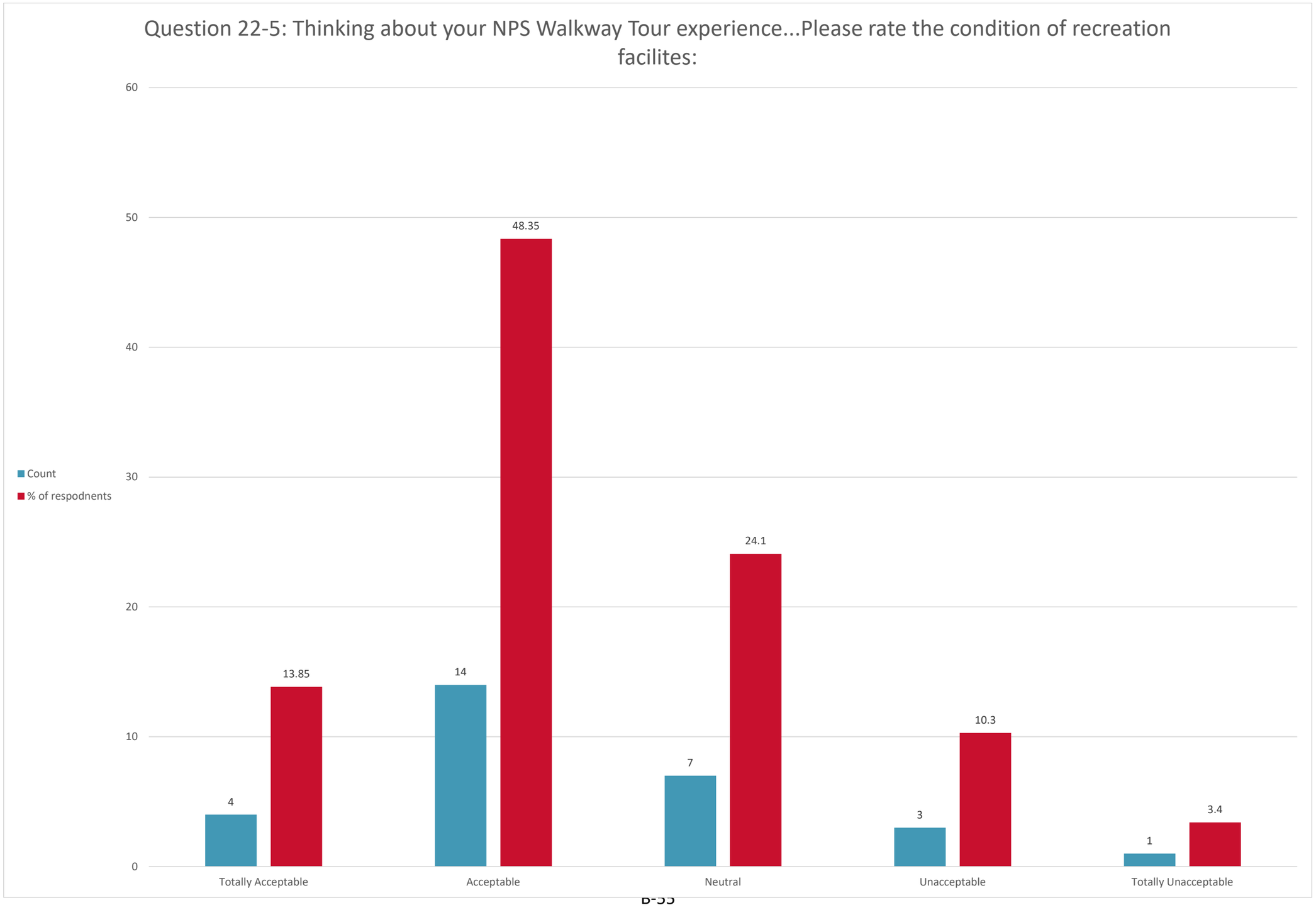

Question 21-8: Thinking about your visit to the E.L. Field Powerhouse Visitor Center...Please rate your overall experience:
Count
4
3
2
1
0
1
0
1
3
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

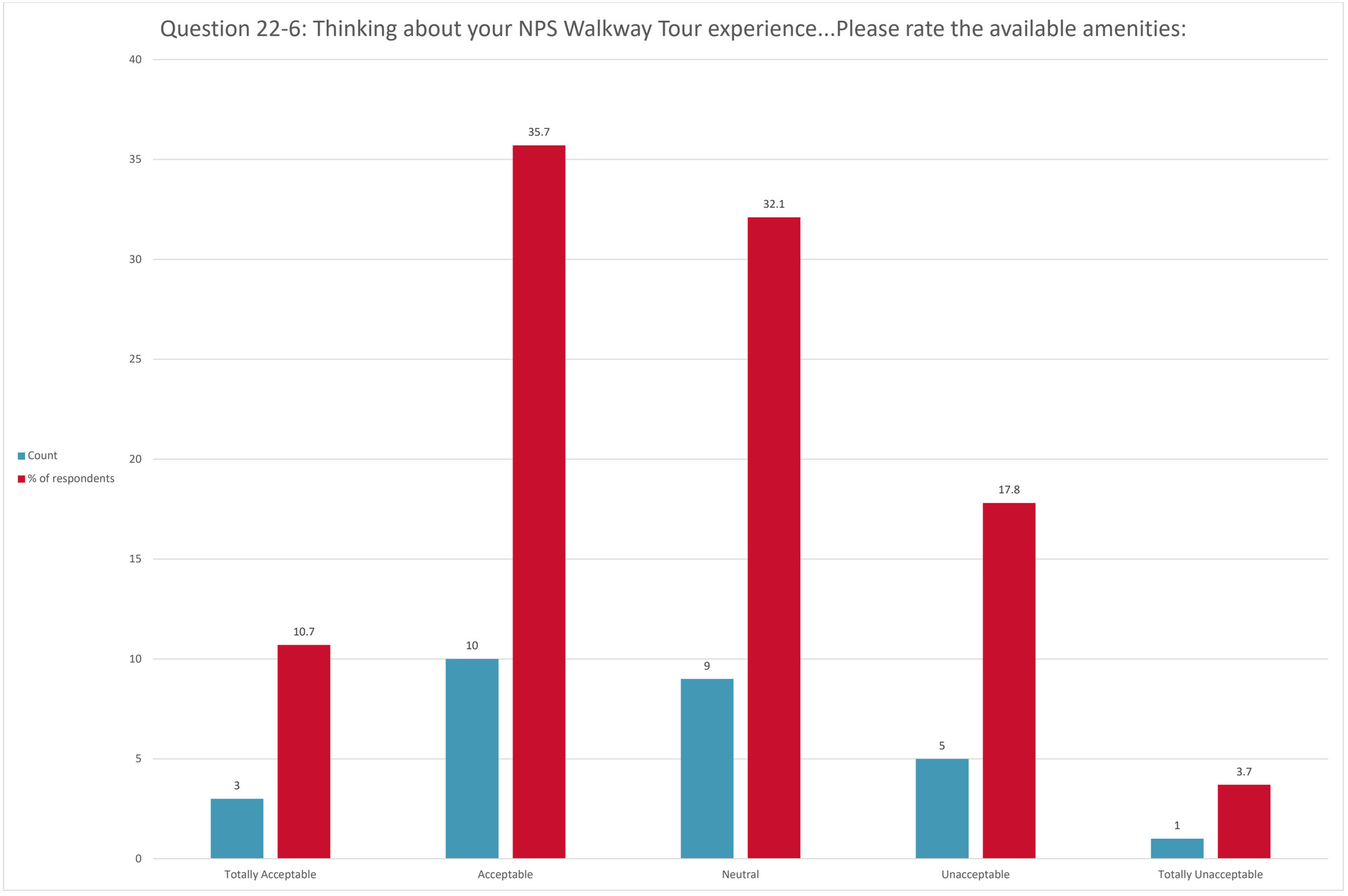

Question 22-1: Thinking about your NPS Walkway Tour experience...Please rate the accessibility:
60
50
40
30
20
10
0
Count
% of respondents
4
13.3
15
50
9
30
2
6.7
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

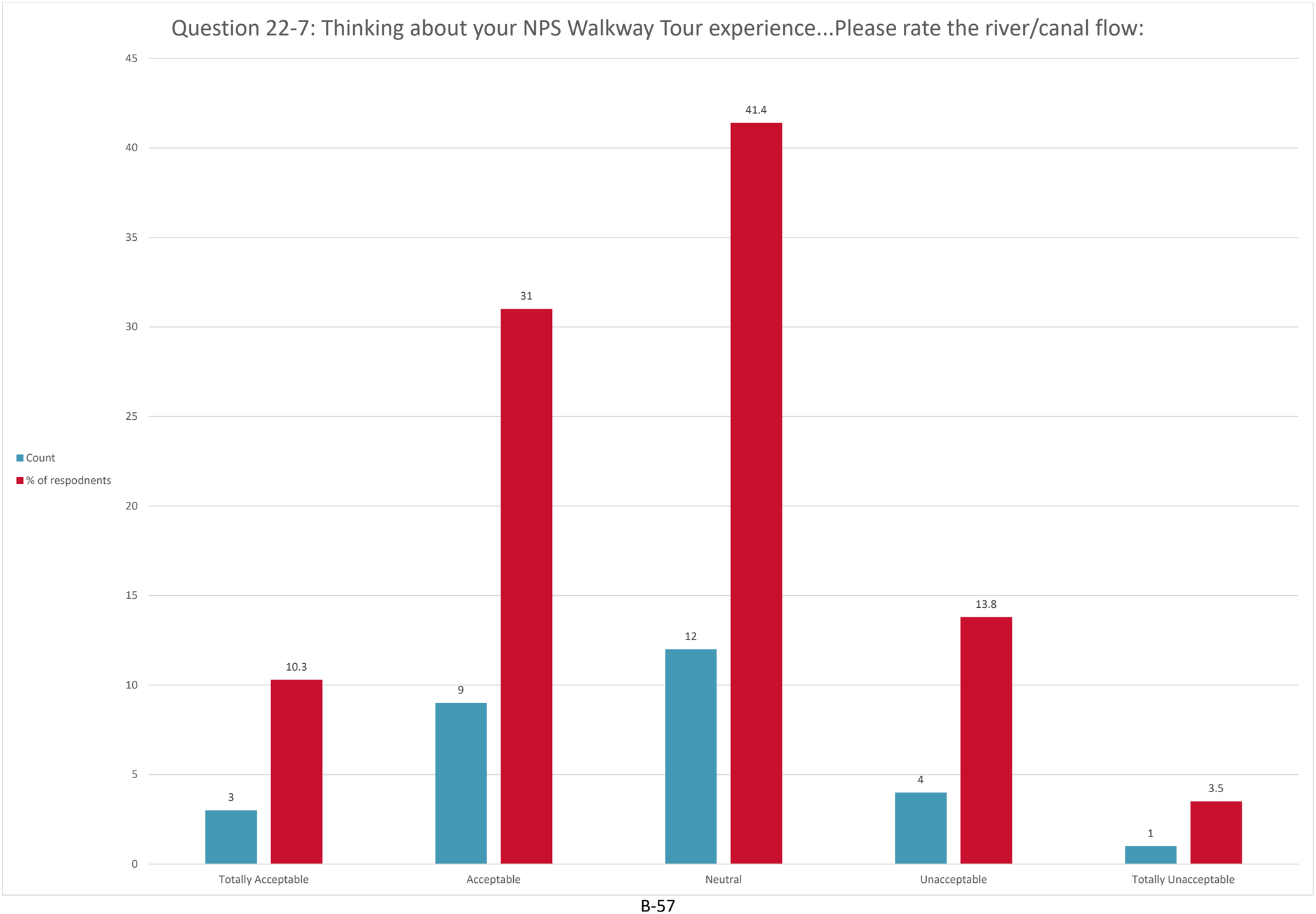

Question 22-2: Thinking about your NPS Walkway Tour experience...Please rate the parking:
60
50
40
30
20
10
0
Count
% of respondents
50
40
11
10
10
4
4
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

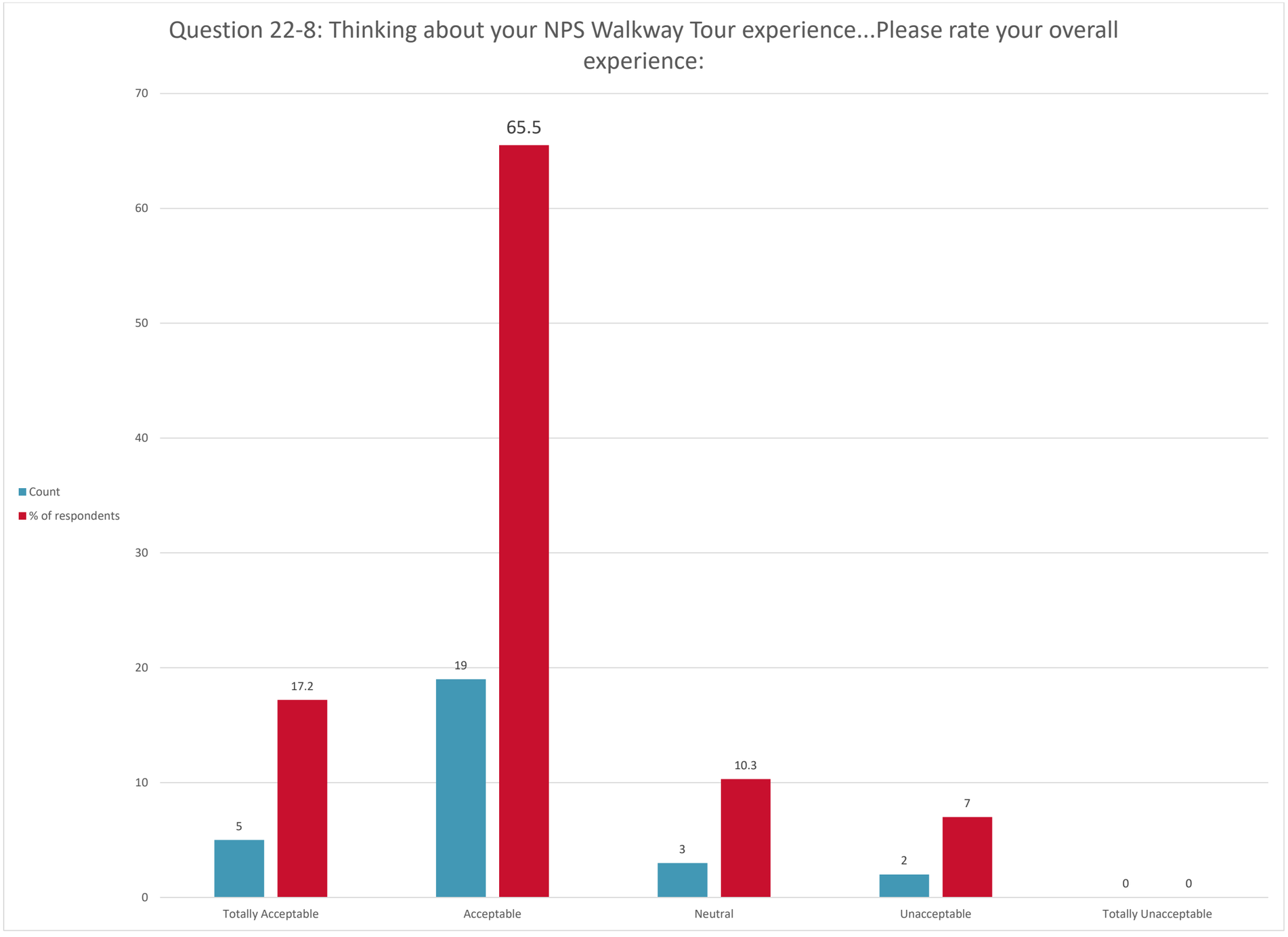

Question 22-3: Thinking about your NPS Walkway Tour experience...Please rate the crowding:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
40
30
30
7
14
7
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

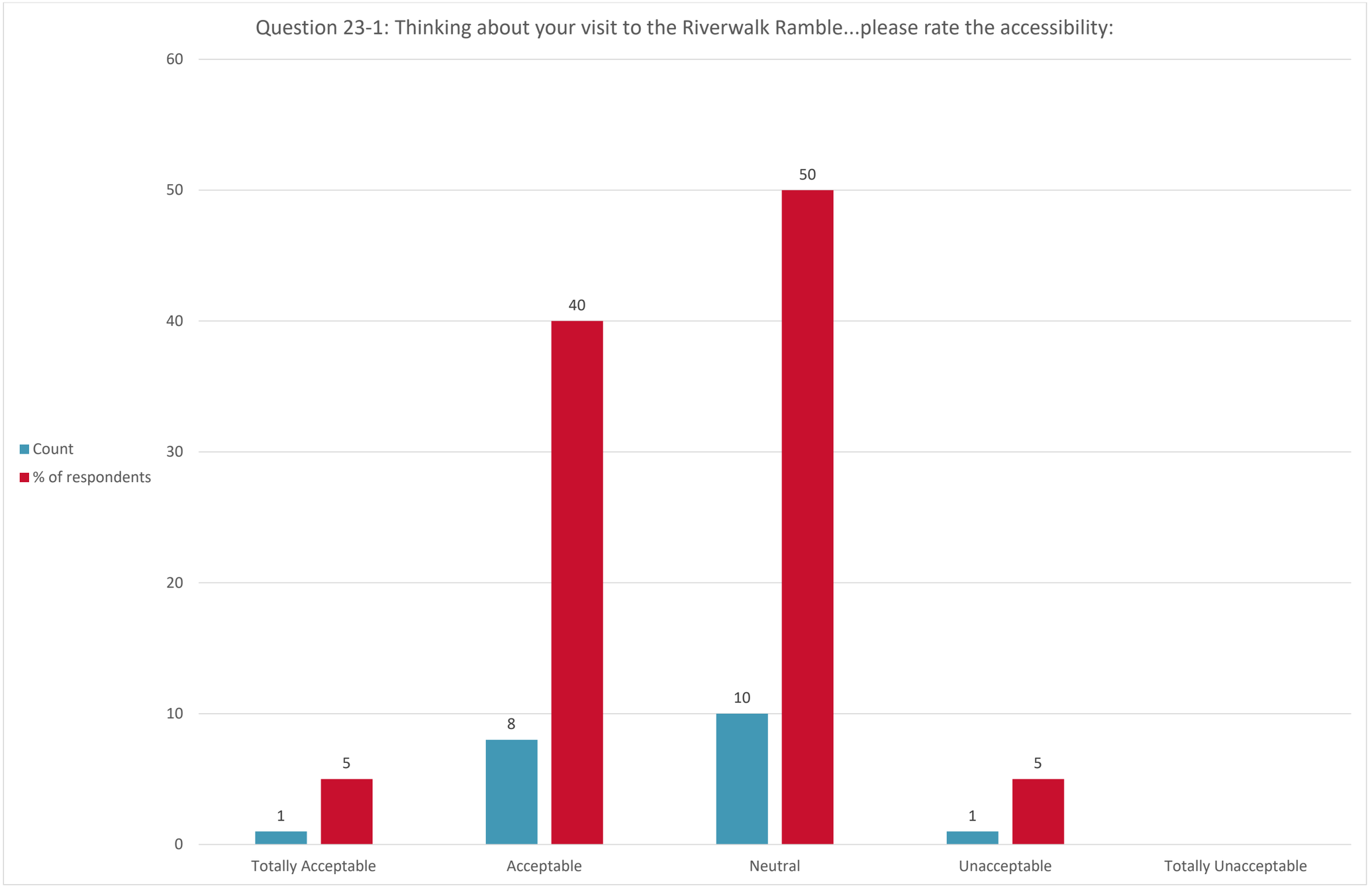

Question 22-4: Thinking about your NPS Walkway Tour experience...Please rate the safety:
Count
% of respondents
60
50
40
30
20
10
0
55.2
24.1
16
13.8
7
4
3.45
1
3.45
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

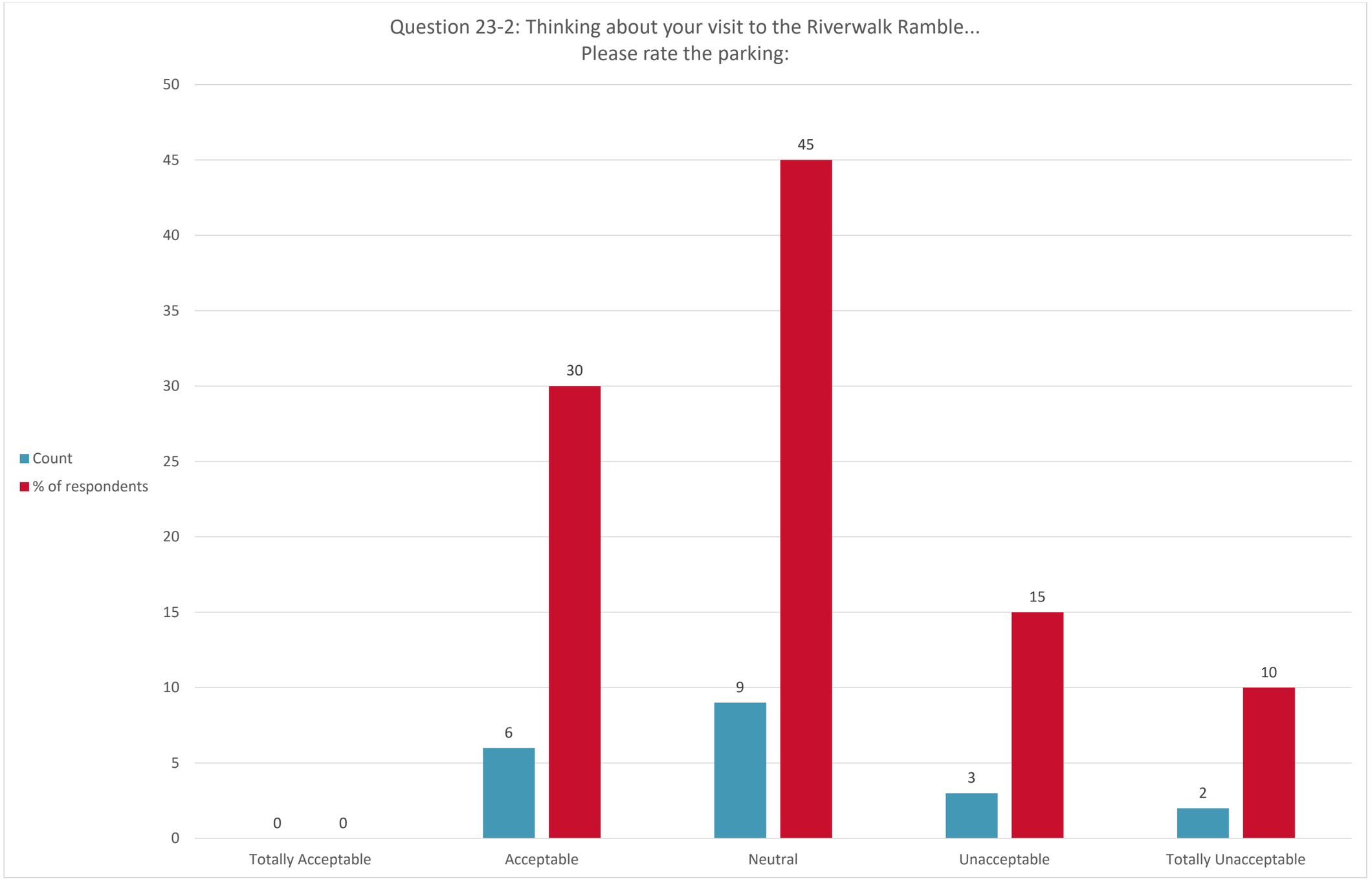

Question 22-5: Thinking about your NPS Walkway Tour experience...Please rate the condition of recreation facilites:
Count
% of respodnents
60
50
40
30
20
10
0
48.35
13.85
14
24.1
10.3
4
7
3
3.4
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

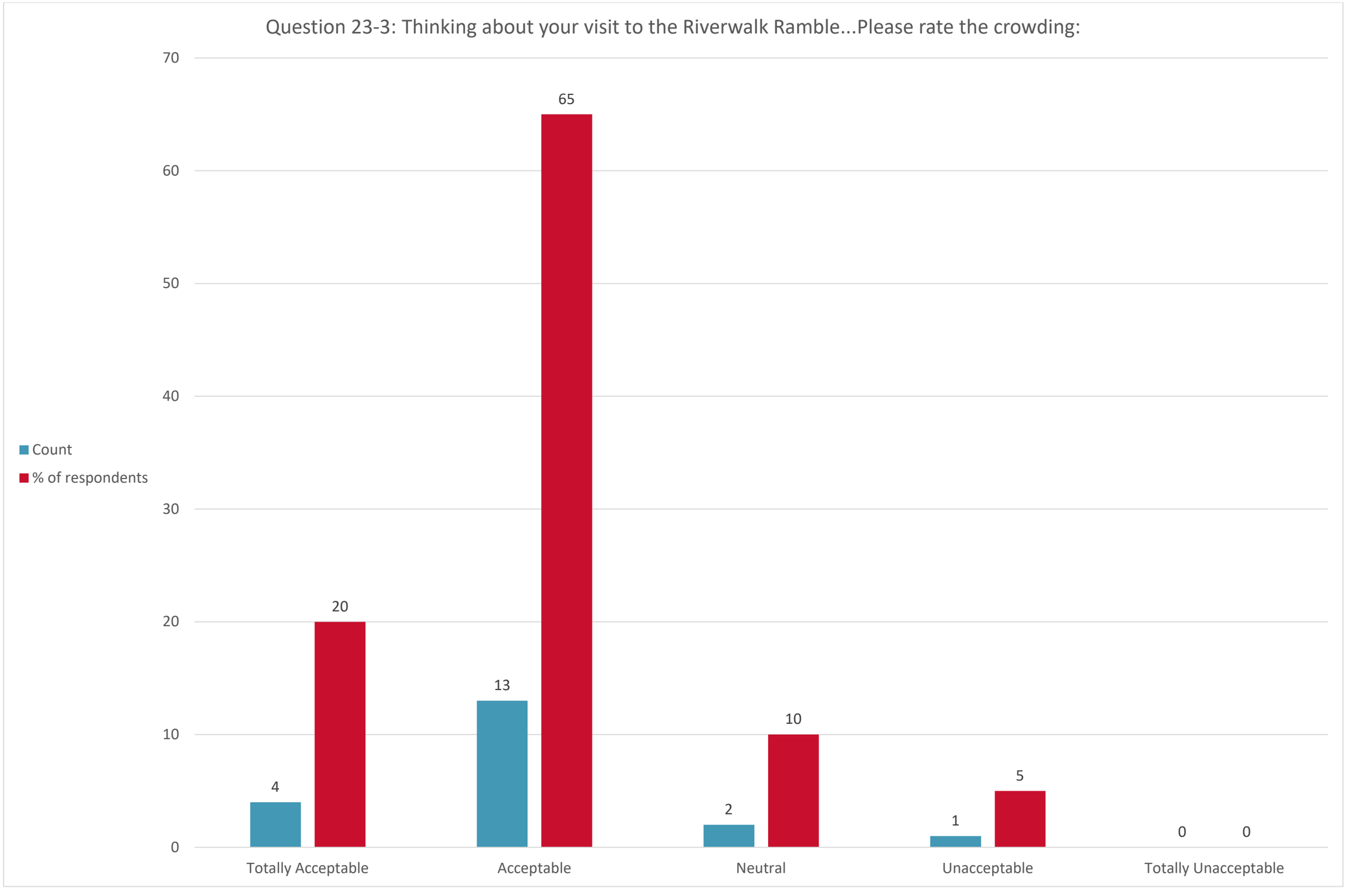

Question 22-6: Thinking about your NPS Walkway Tour experience...Please rate the available amenities:
Count
% of respondents
40
35
30
25
20
15
10
5
0
3
10.7
10
35.7
9
32.1
5
17.8
1
3.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

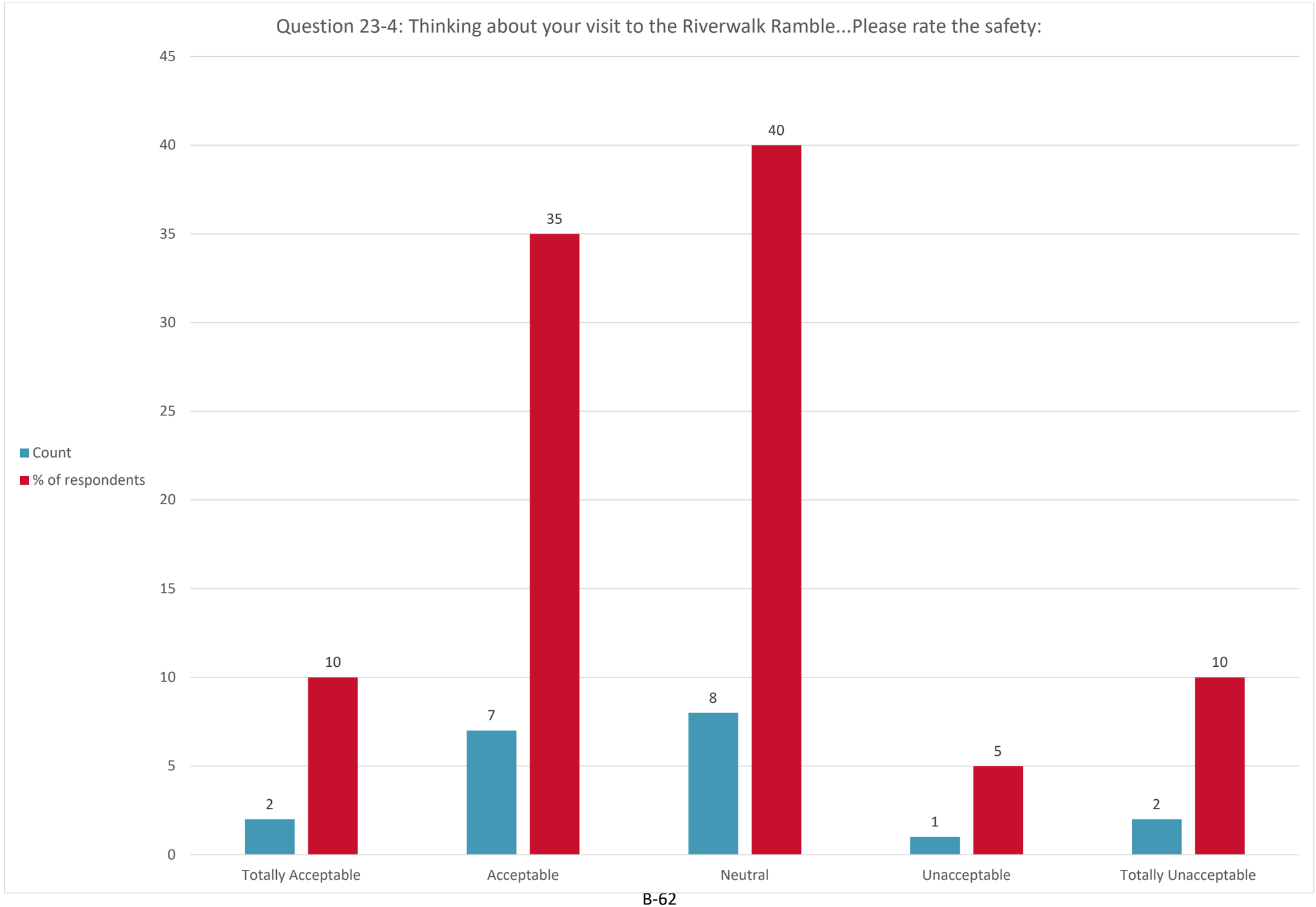

Question 22-7: Thinking about your NPS Walkway Tour experience...Please rate the river/canal flow:
45
40
35
30
25
20
15
10
5
0
Count
% of respodnents
3
10.3
9
31
12
41.4
4
13.8
1
3.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

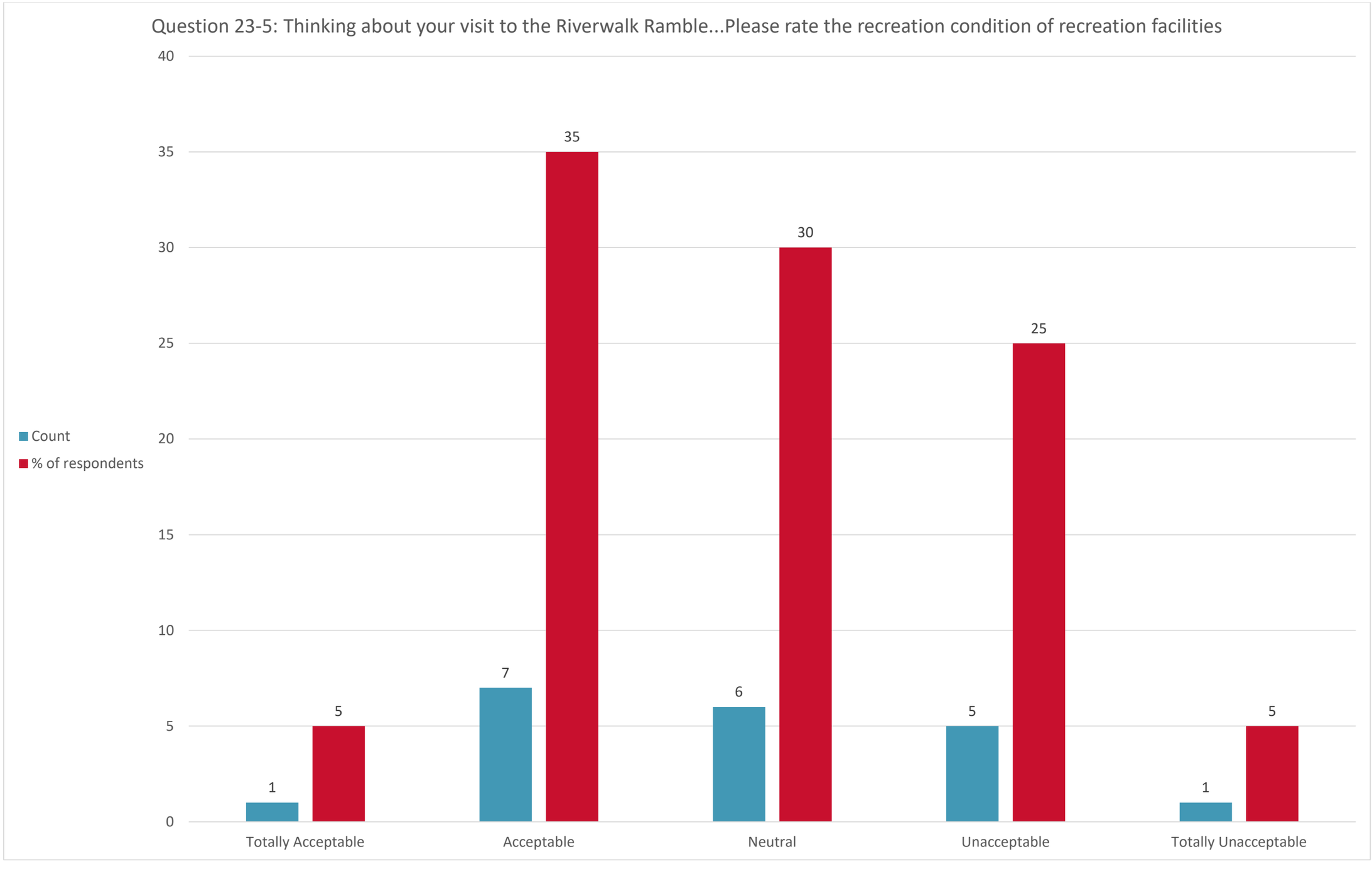

Question 22-8: Thinking about your NPS Walkway Tour experience...Please rate your overall experience:
Count
% of respondents
70
60
50
40
30
20
10
0
65.5
17.2
19
10.3
7
5
3
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

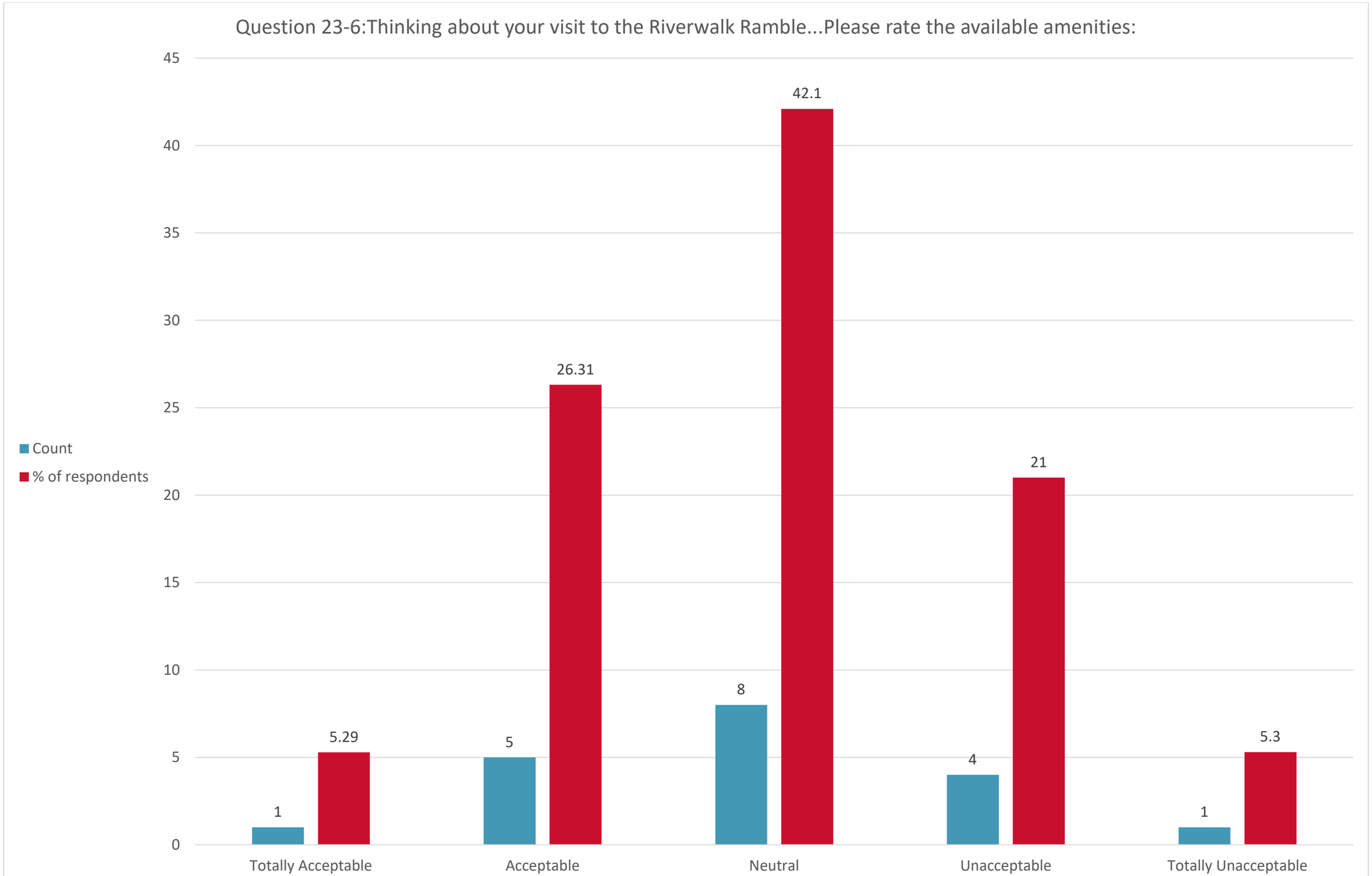

Question 23-1: Thinking about your visit to the Riverwalk Ramble...please rate the accessibility:
60
50
40
30
20
10
0
Count
% of respondents
1
5
8
40
10
50
1
5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

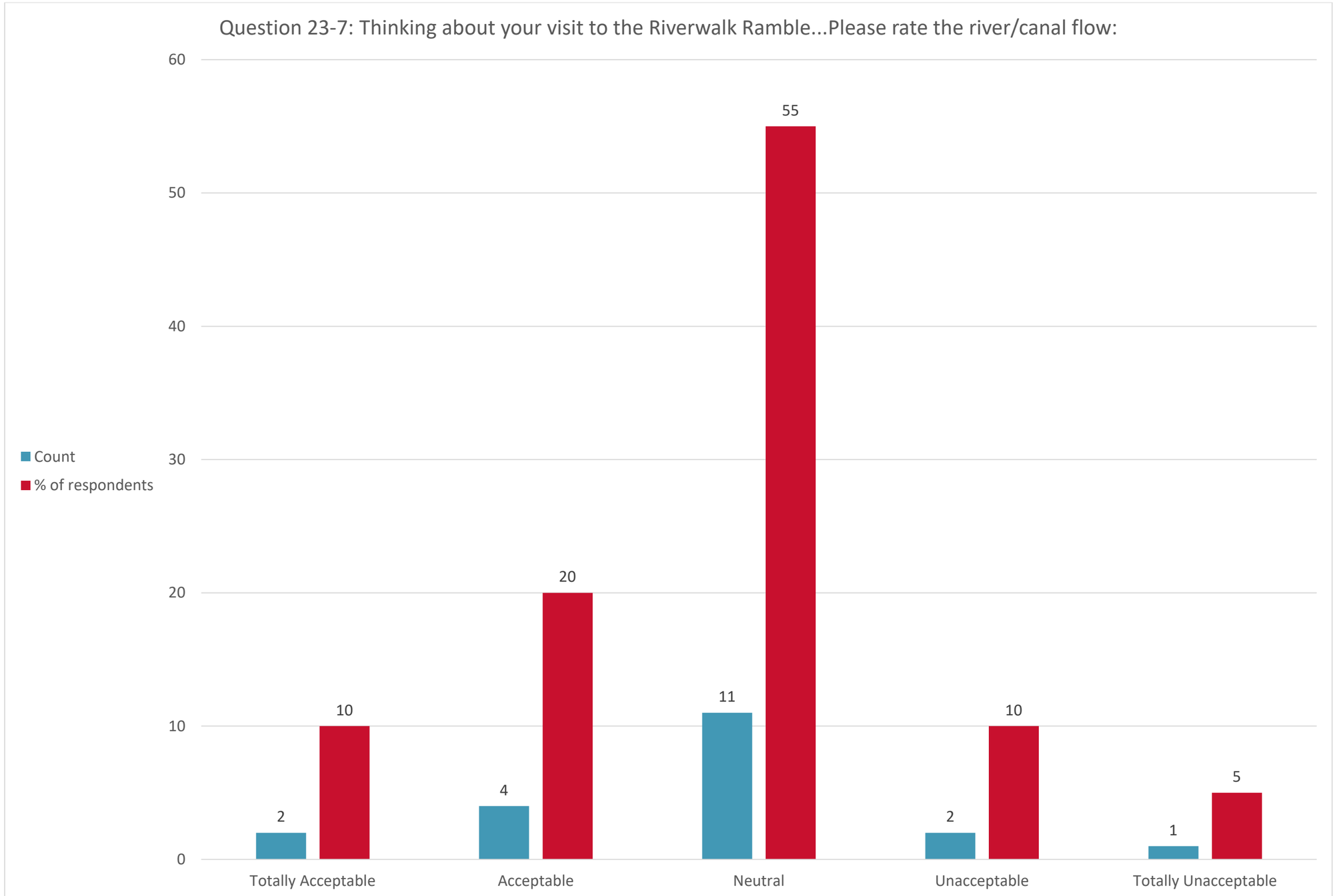

Question 23-2: Thinking about your visit to the Riverwalk Ramble...
Please rate the parking:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
0
0
6
30
9
45
3
15
2
10
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

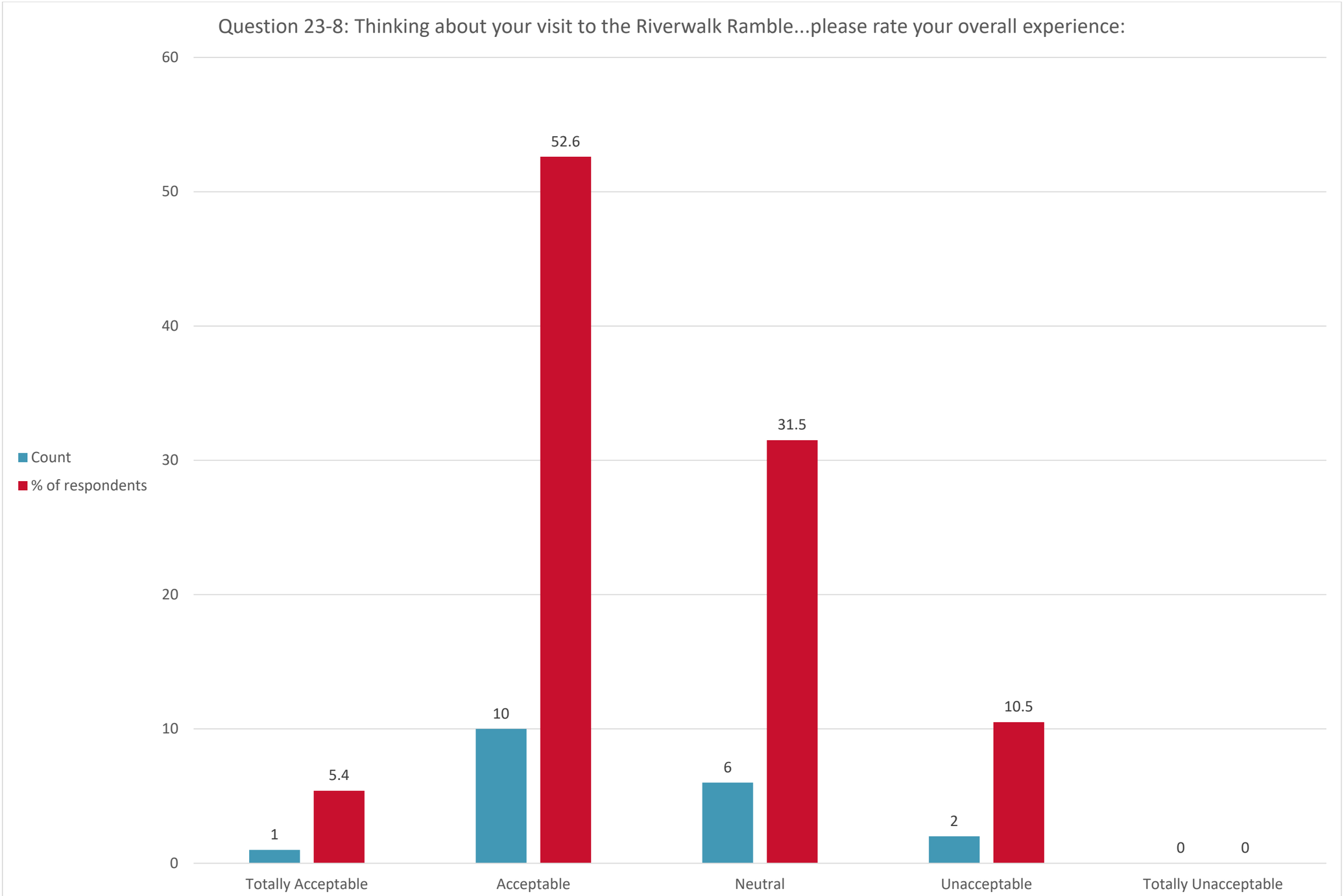

Question 23-3: Thinking about your visit to the Riverwalk Ramble...Please rate the crowding:
70
60
50
40
30
20
10
0
Count
% of respondents
4
20
13
65
2
10
1
5
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

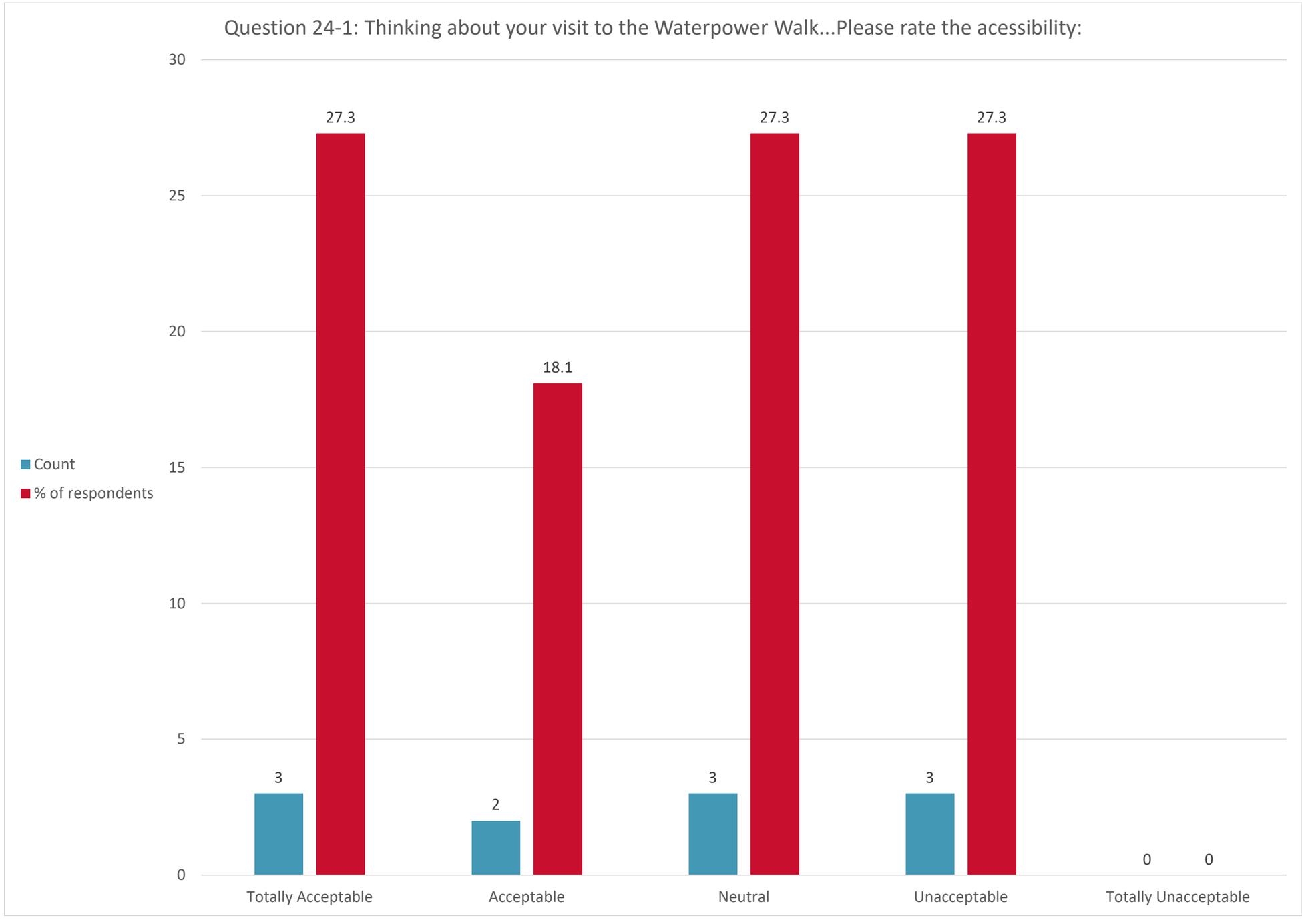

Question 23-4: Thinking about your visit to the Riverwalk Ramble...Please rate the safety:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
2
10
7
35
8
40
1
5
2
10
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

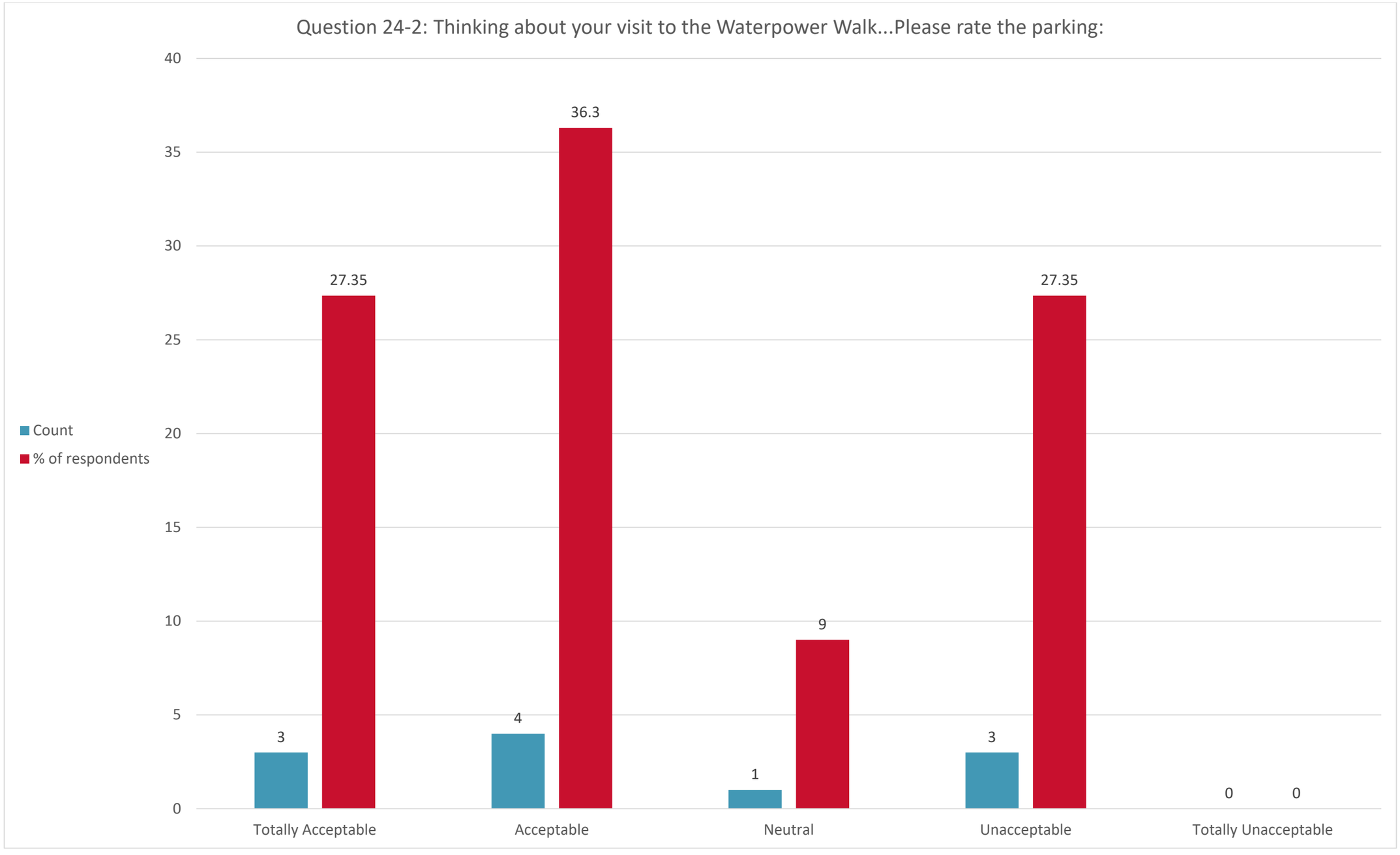

Question 23-5: Thinking about your visit to the Riverwalk Ramble...Please rate the recreation condition of recreation facilities
Count
% of respondents
40
35
30
25
20
15
10
5
0
35
30
25
1
5
7
6
5
1
5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

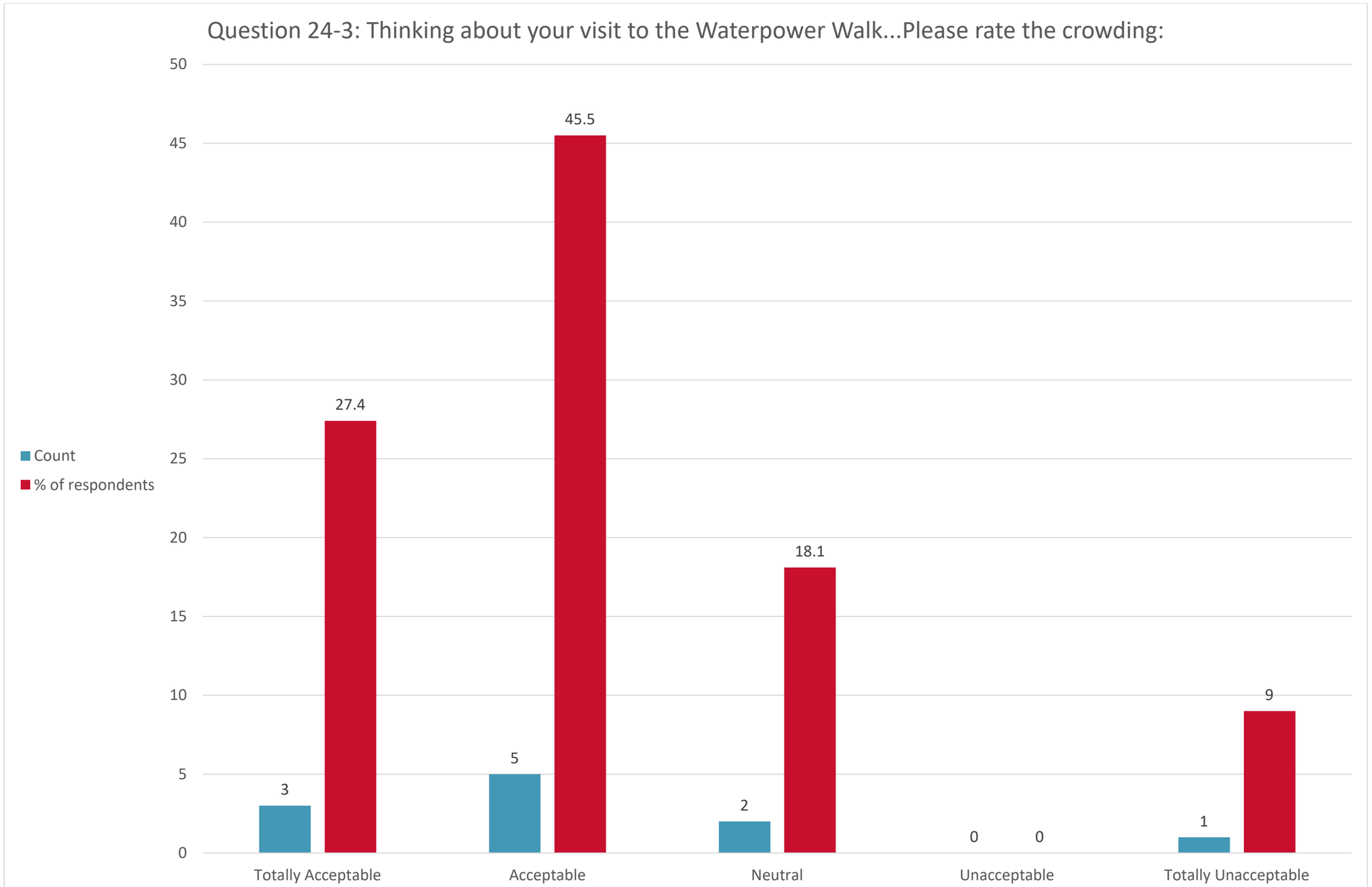

Question 23-6:Thinking about your visit to the Riverwalk Ramble...Please rate the available amenities:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
1
5.29
5
26.31
8
42.1
4
21
1
5.3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

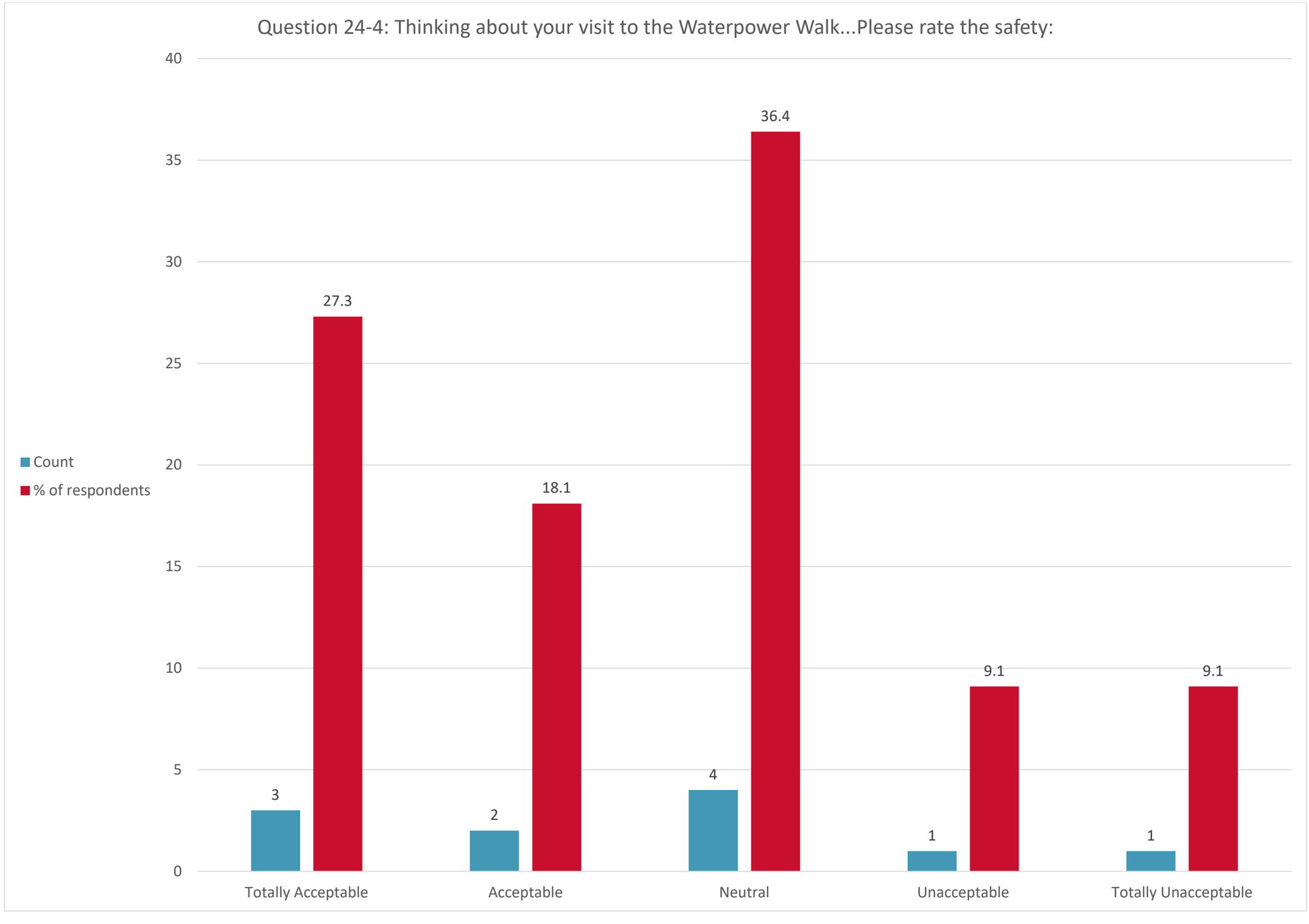

Question 23-7: Thinking about your visit to the Riverwalk Ramble...Please rate the river/canal flow:
Count
% of respondents
60
50
40
30
20
10
0
55
20
10
11
10
5
4
2
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

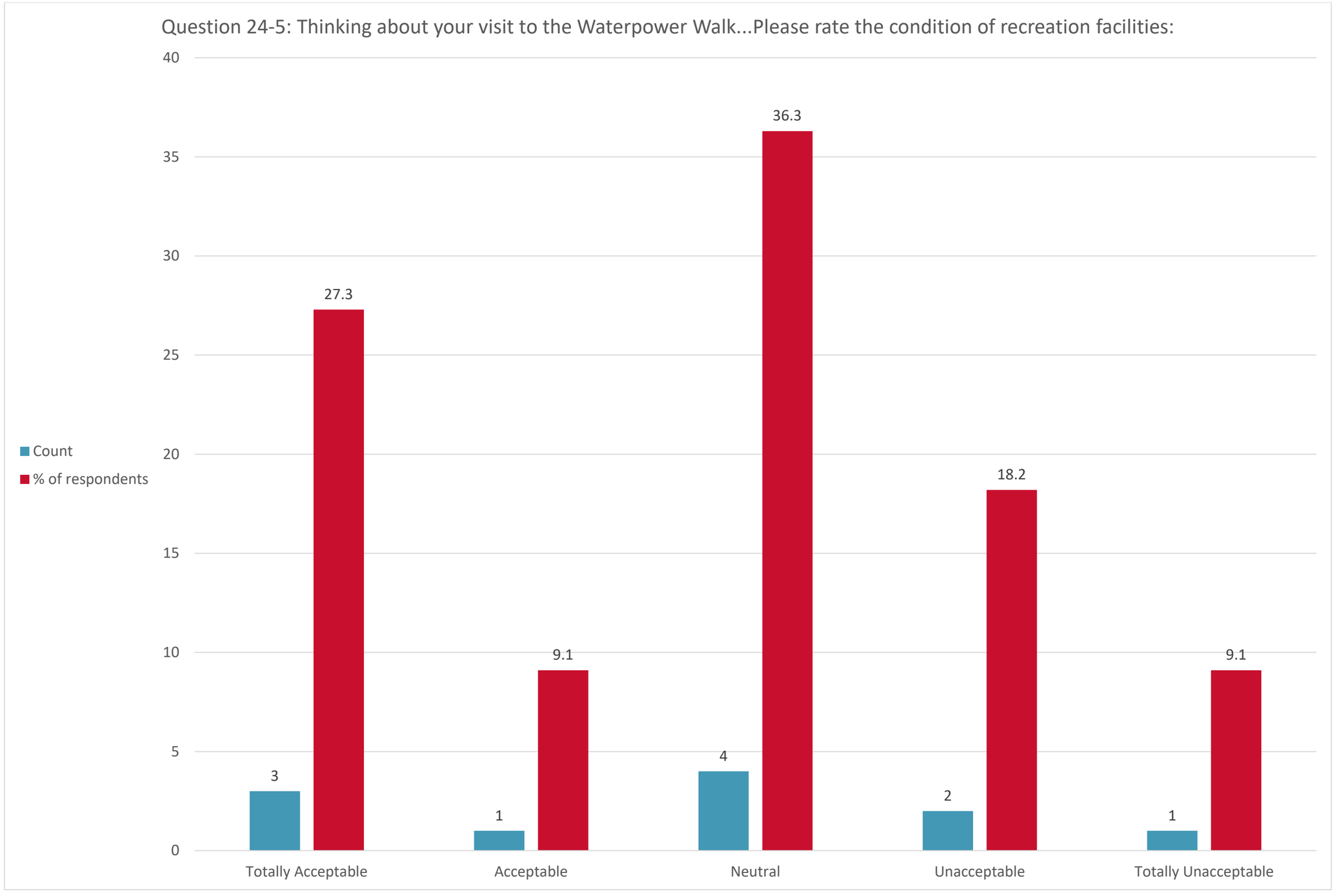

Question 23-8: Thinking about your visit to the Riverwalk Ramble...please rate your overall experience:
Count
% of respondents
60
50
40
30
20
10
0
52.6
31.5
10.5
5.4
1
10
6
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

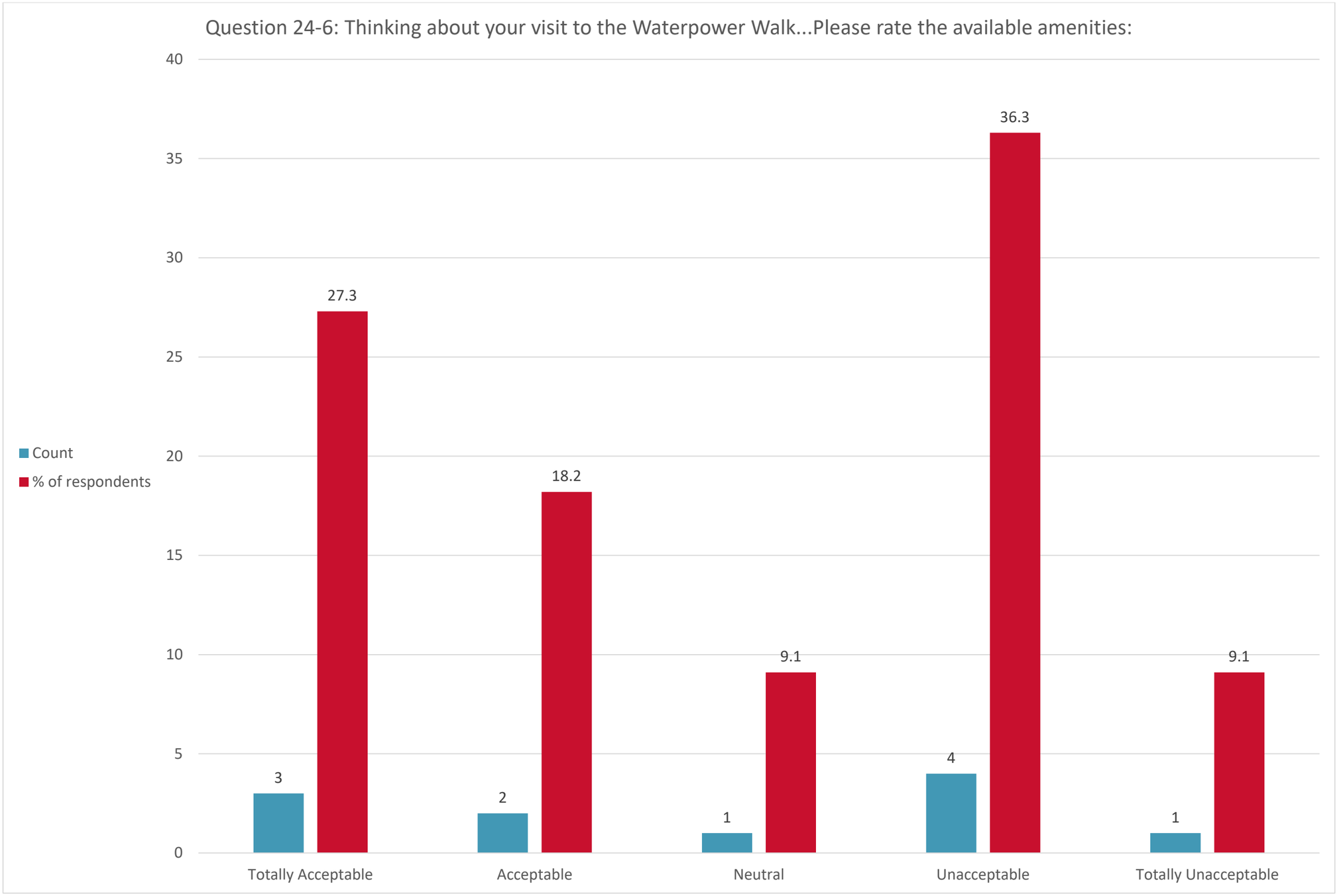

Question 24-1: Thinking about your visit to the Waterpower Walk...Please rate the acessibility:
Count
% of respondents
30
25
20
15
10
5
0
27.3
18.1
27.3
27.3
3
2
3
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

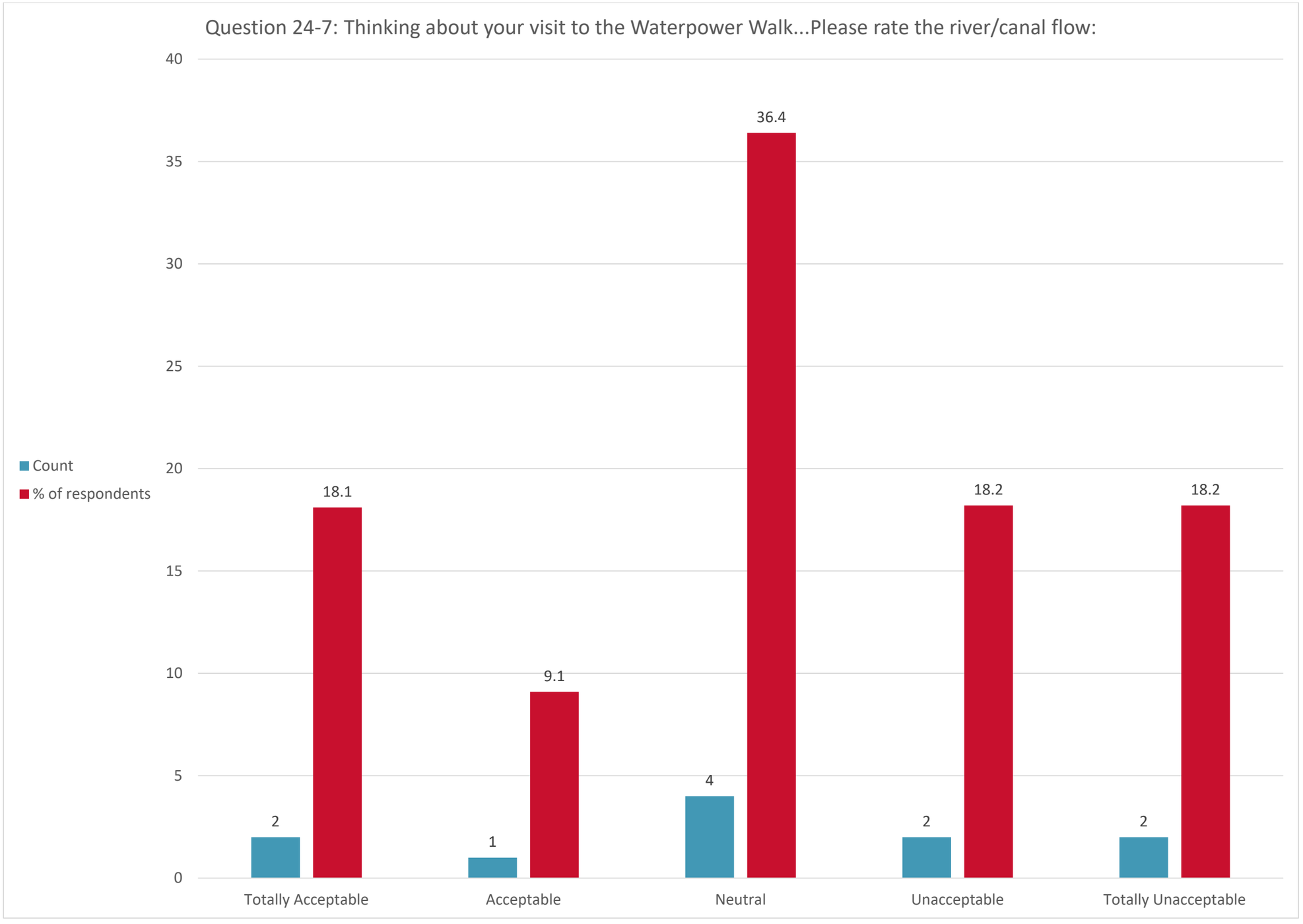

Question 24-2: Thinking about your visit to the Waterpower Walk...Please rate the parking:
Count
% of respondents
40
35
30
25
20
15
10
5
0
27.35
36.3
27.35
3
4
1
9
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

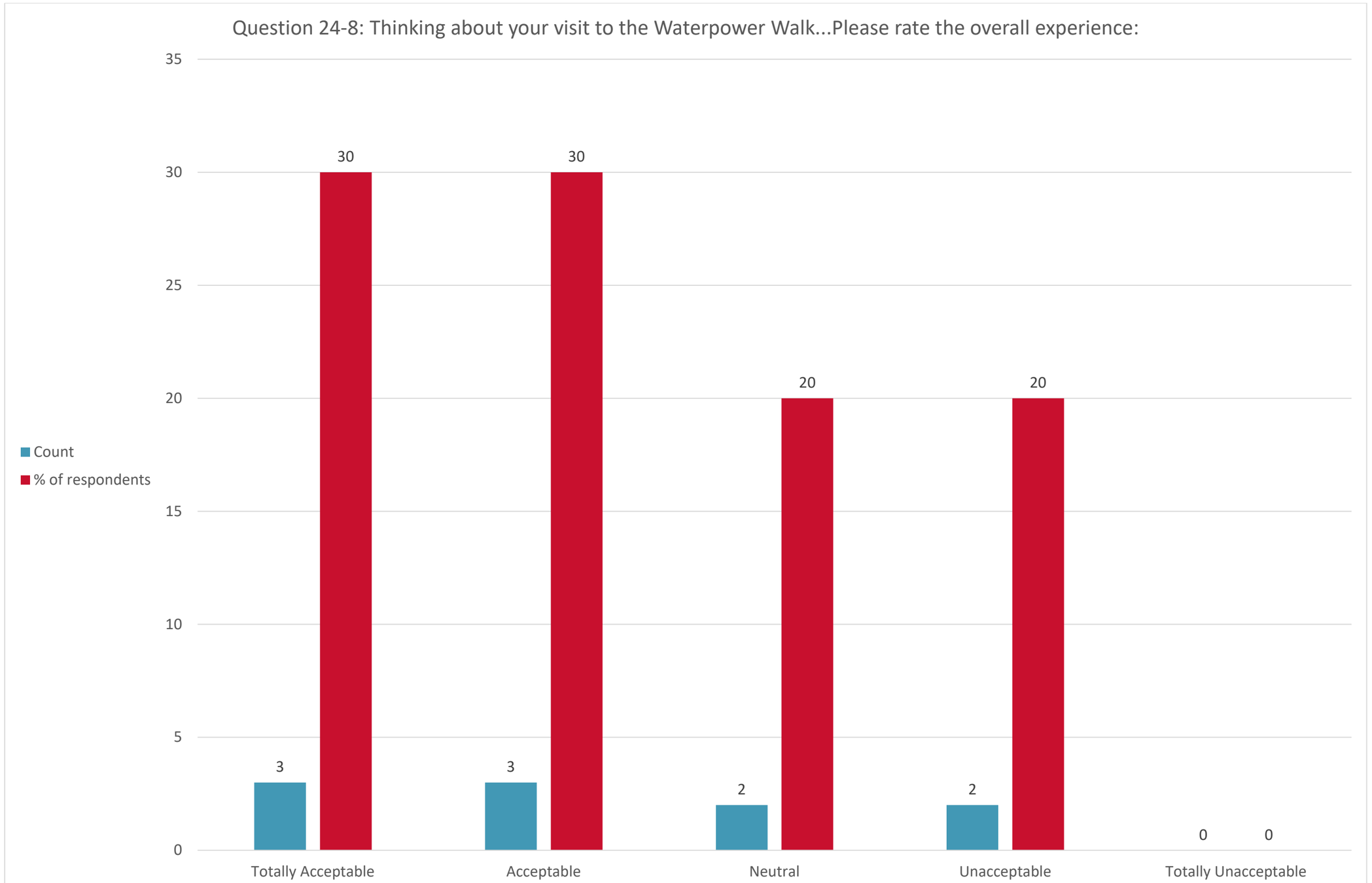

Question 24-3: Thinking about your visit to the Waterpower Walk...Please rate the crowding:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
27.4
45.5
18.1
3
5
2
0
0
1
9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

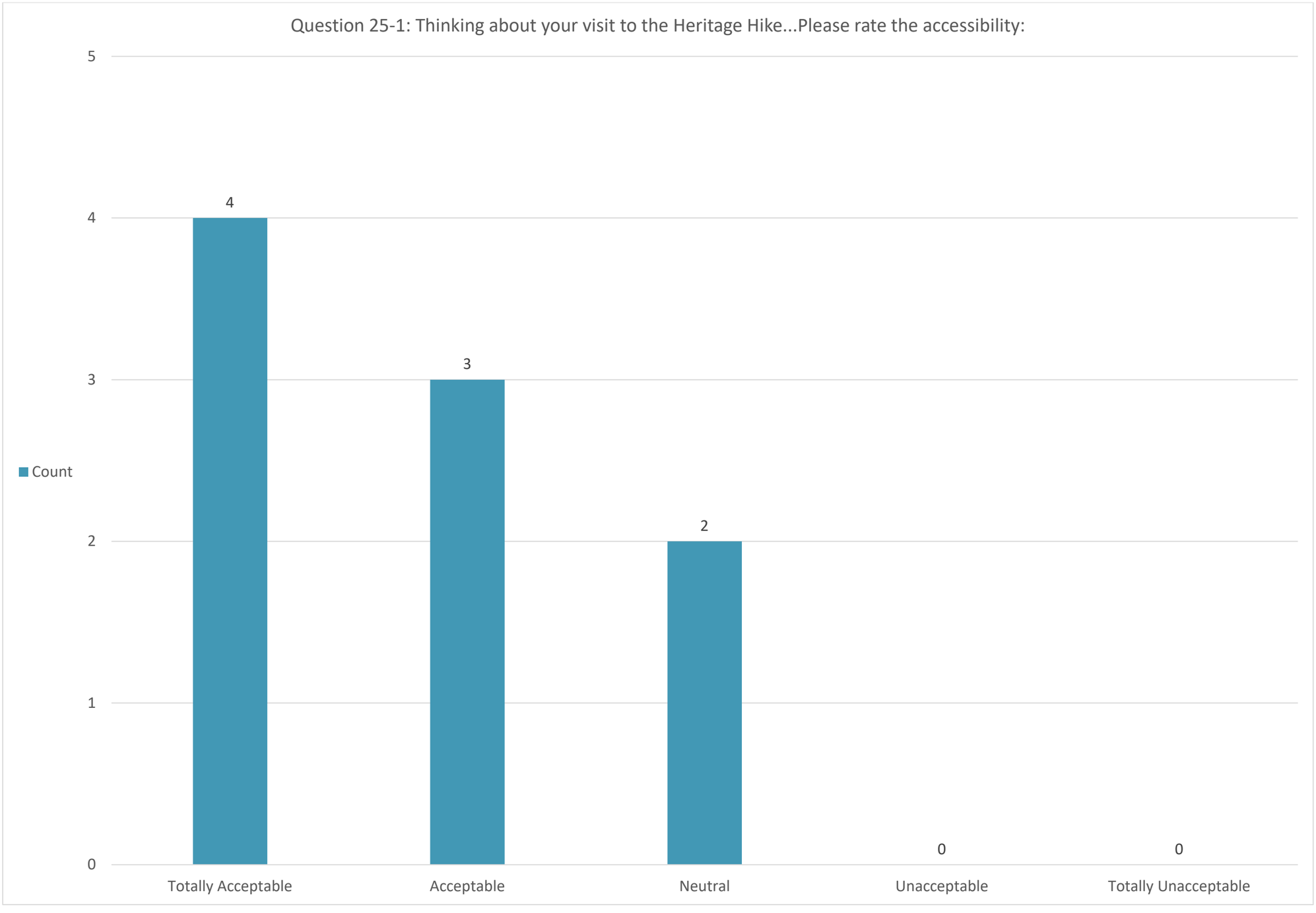

Question 24-4: Thinking about your visit to the Waterpower Walk...Please rate the safety:
Count
% of respondents
40
35
30
25
20
15
10
5
0
27.3
36.4
18.1
9.1
9.1
3
2
4
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

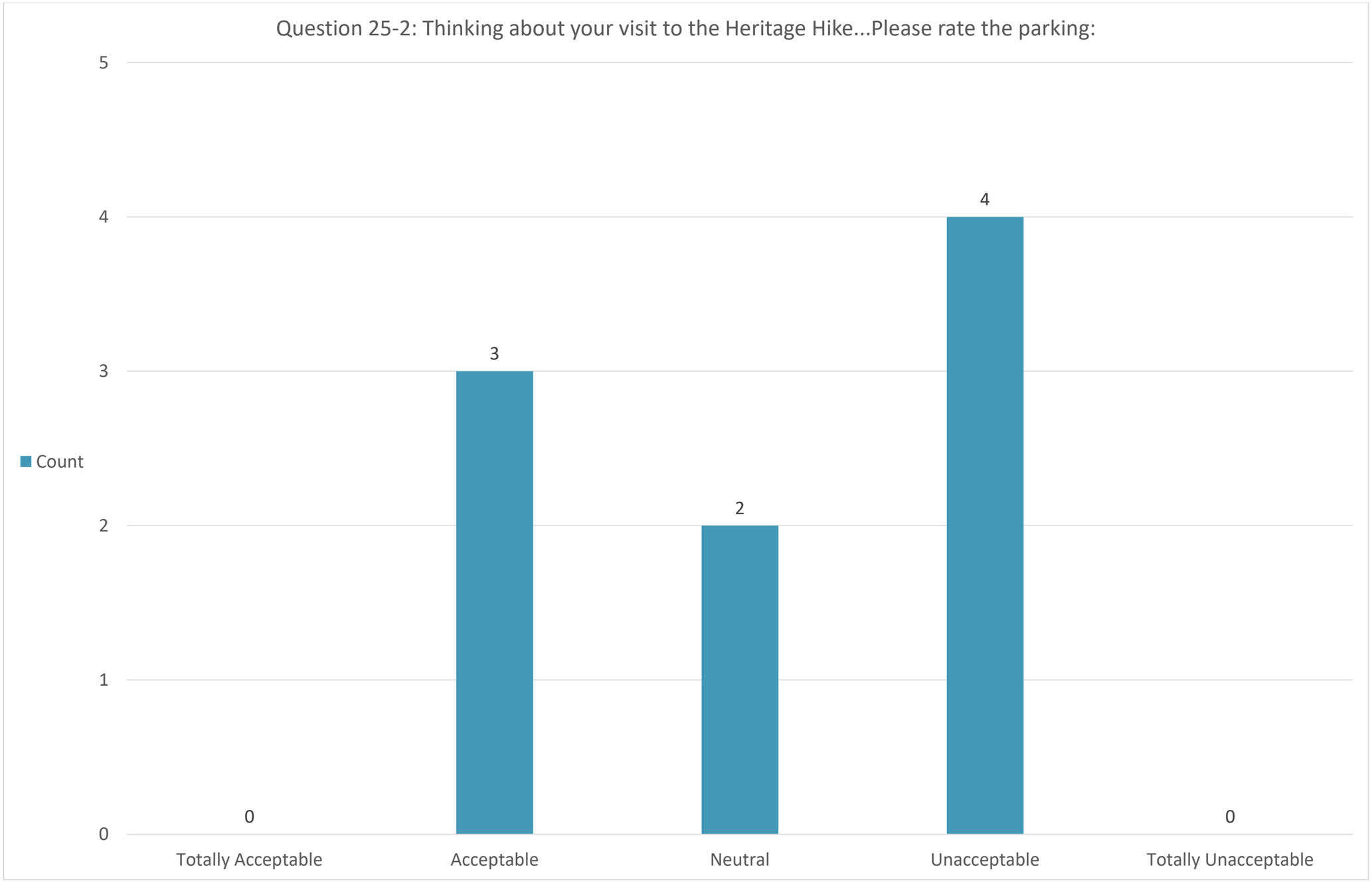

Question 24-5: Thinking about your visit to the Waterpower Walk...Please rate the condition of recreation facilities:
Count
% of respondents
40
35
30
25
20
15
10
5
0
27.3
36.3
18.2
9.1
9.1
3
1
4
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

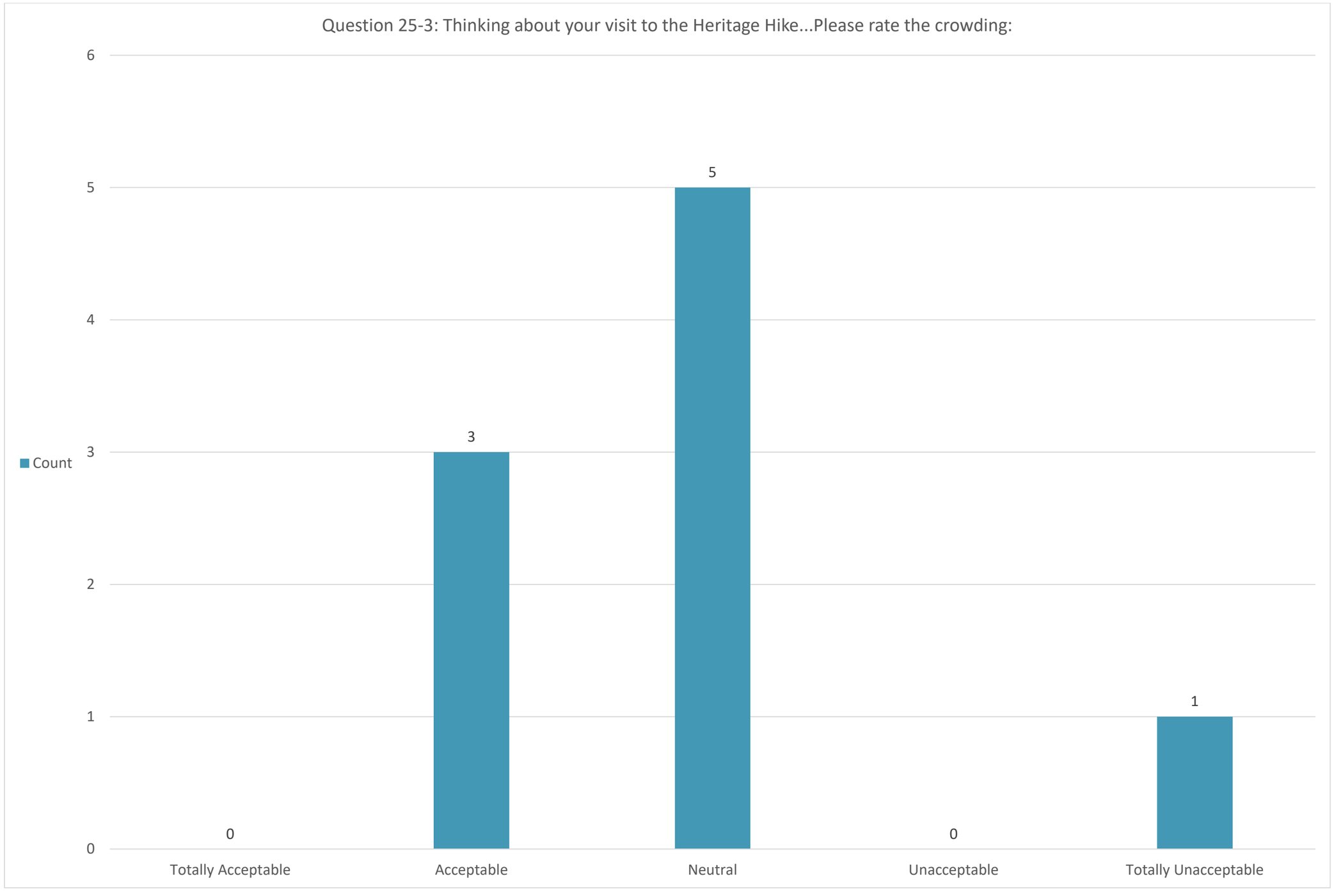

Question 24-6: Thinking about your visit to the Waterpower Walk...Please rate the available amenities:
Count
% of respondents
40
35
30
25
20
15
10
5
0
27.3
18.2
9.1
36.3
9.1
3
2
1
4
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

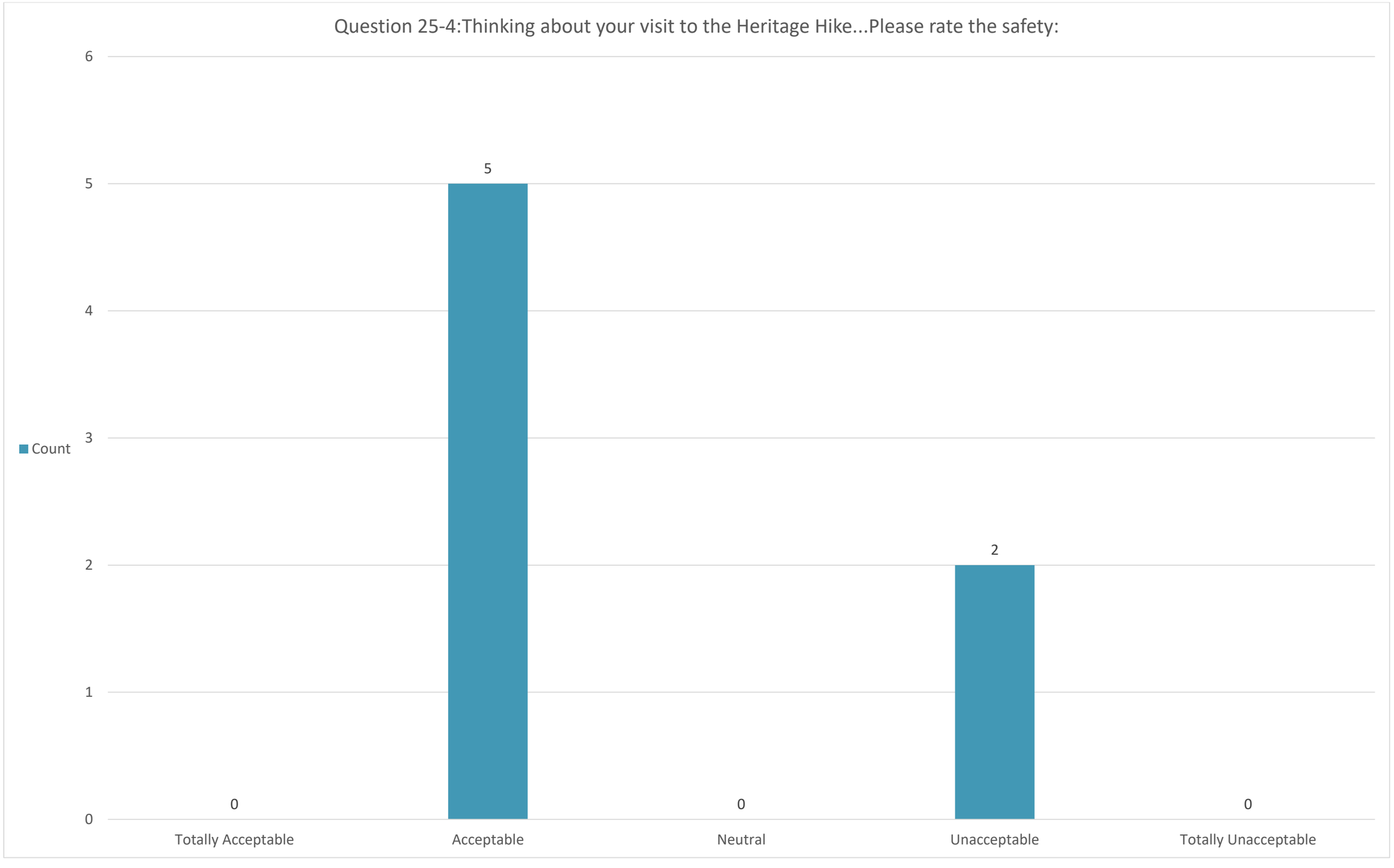

Question 24-7: Thinking about your visit to the Waterpower Walk...Please rate the river/canal flow:
Count
% of respondents
40
35
30
25
20
15
10
5
0
36.4
18.1
18.2
18.2
9.1
4
2
1
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

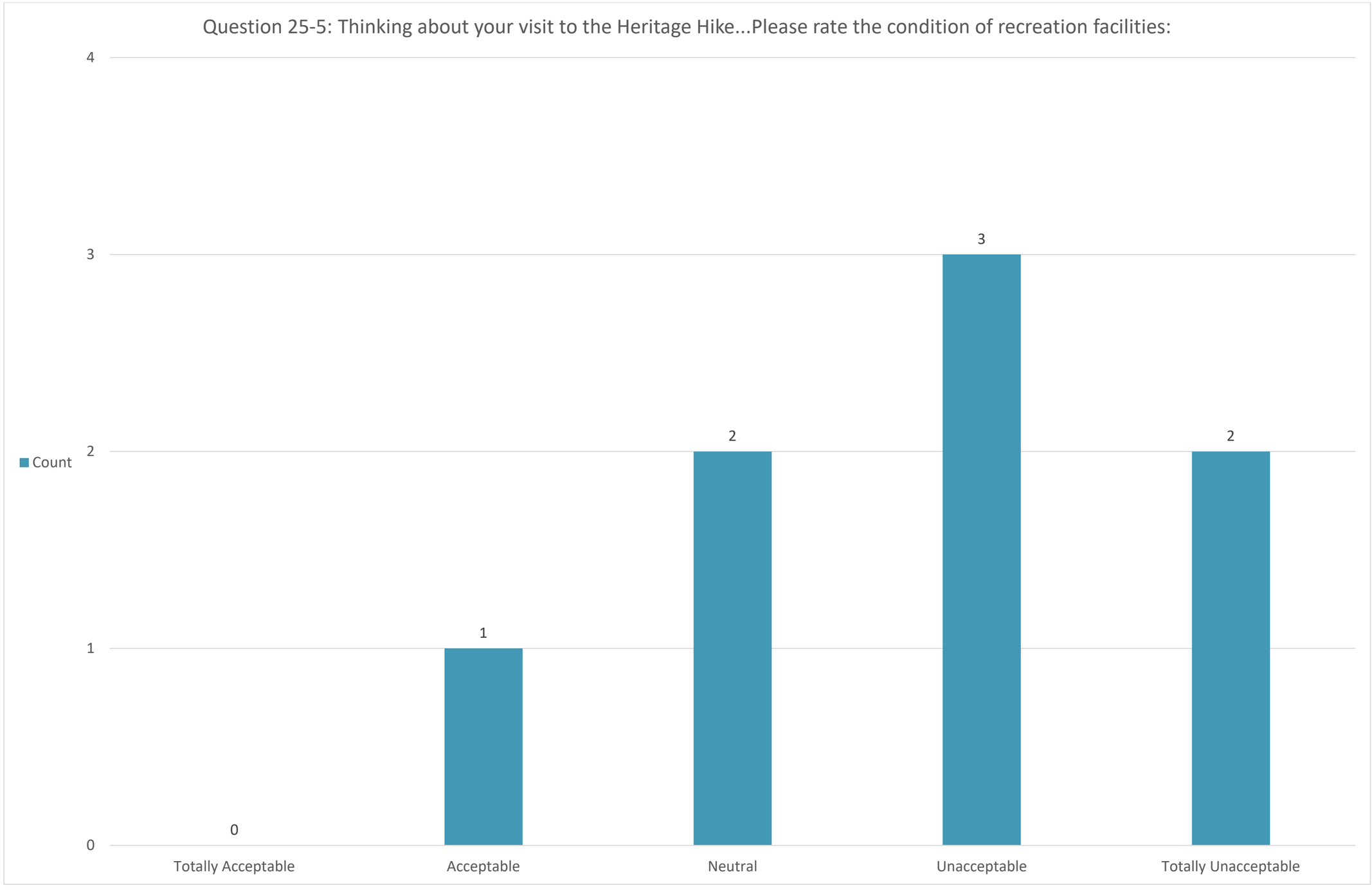

Question 24-8: Thinking about your visit to the Waterpower Walk...Please rate the overall experience:
Count
% of respondents
35
30
25
20
15
10
5
0
30
30
20
20
3
3
2
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

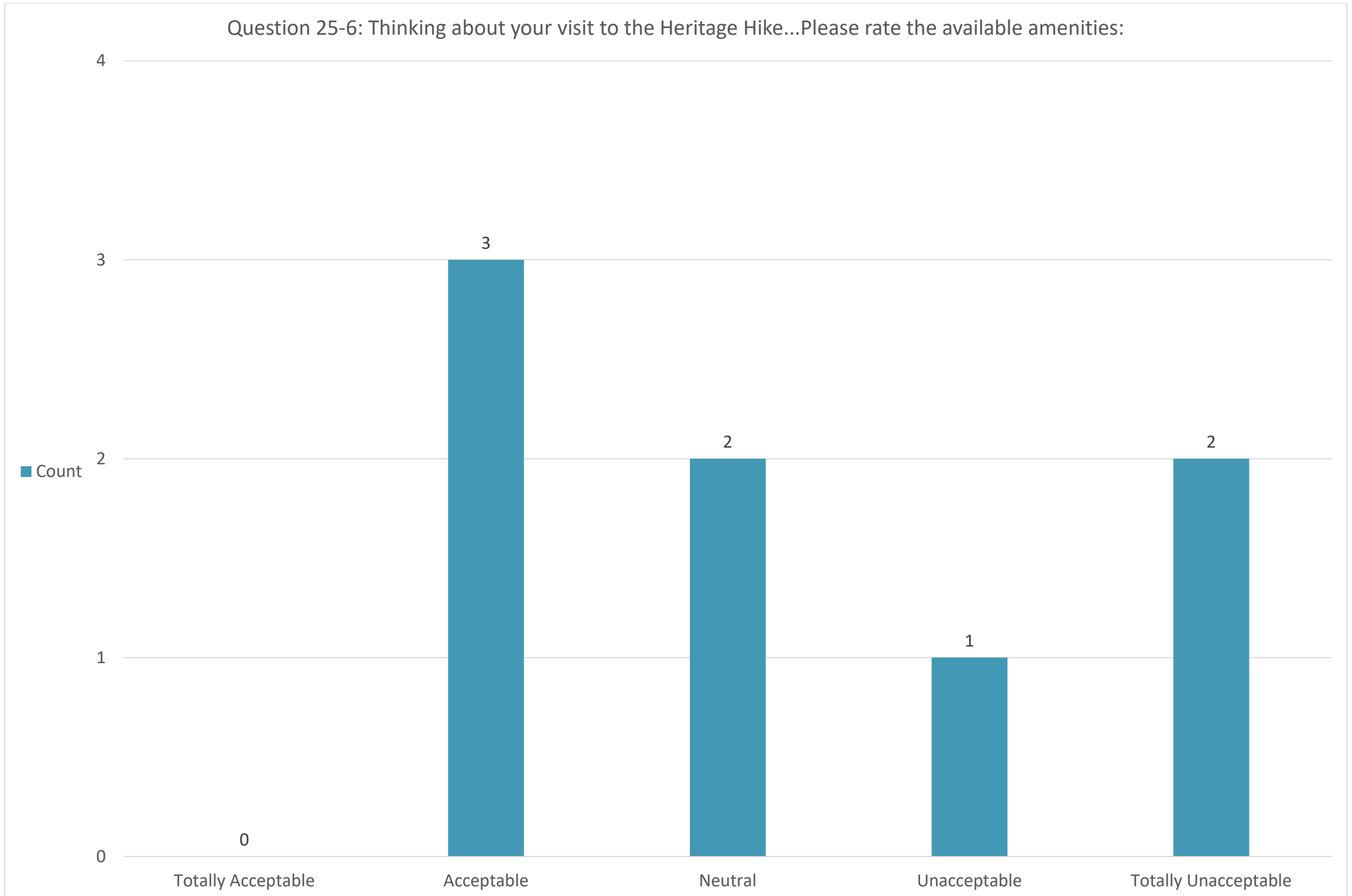

Question 25-1: Thinking about your visit to the Heritage Hike...Please rate the accessibility:
5
4
3
2
1
0
Count
4
3
2
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

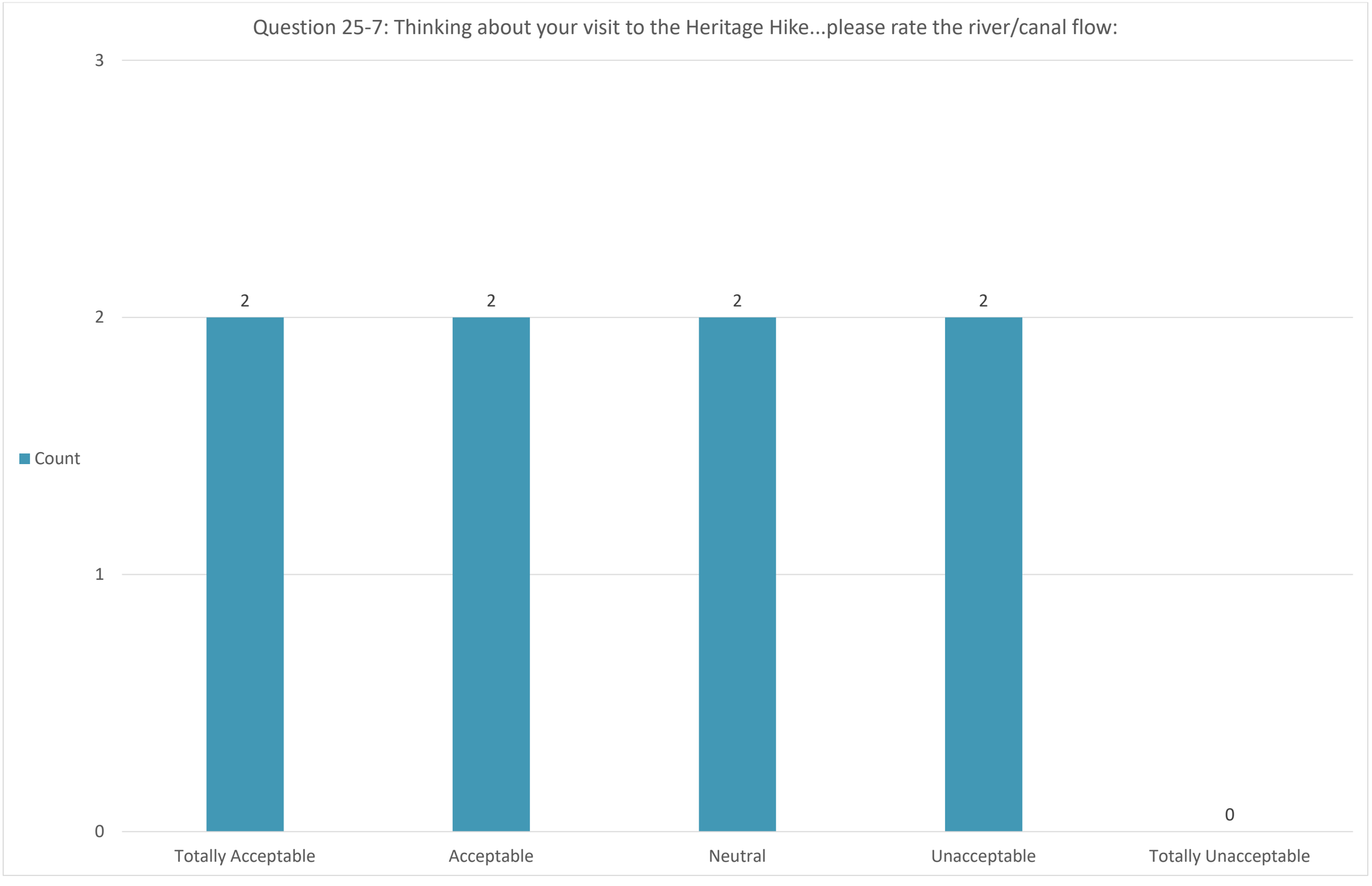

Question 25-2: Thinking about your visit to the Heritage Hike...Please rate the parking:
5
4
3
2
1
0
Count
0
3
2
4
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

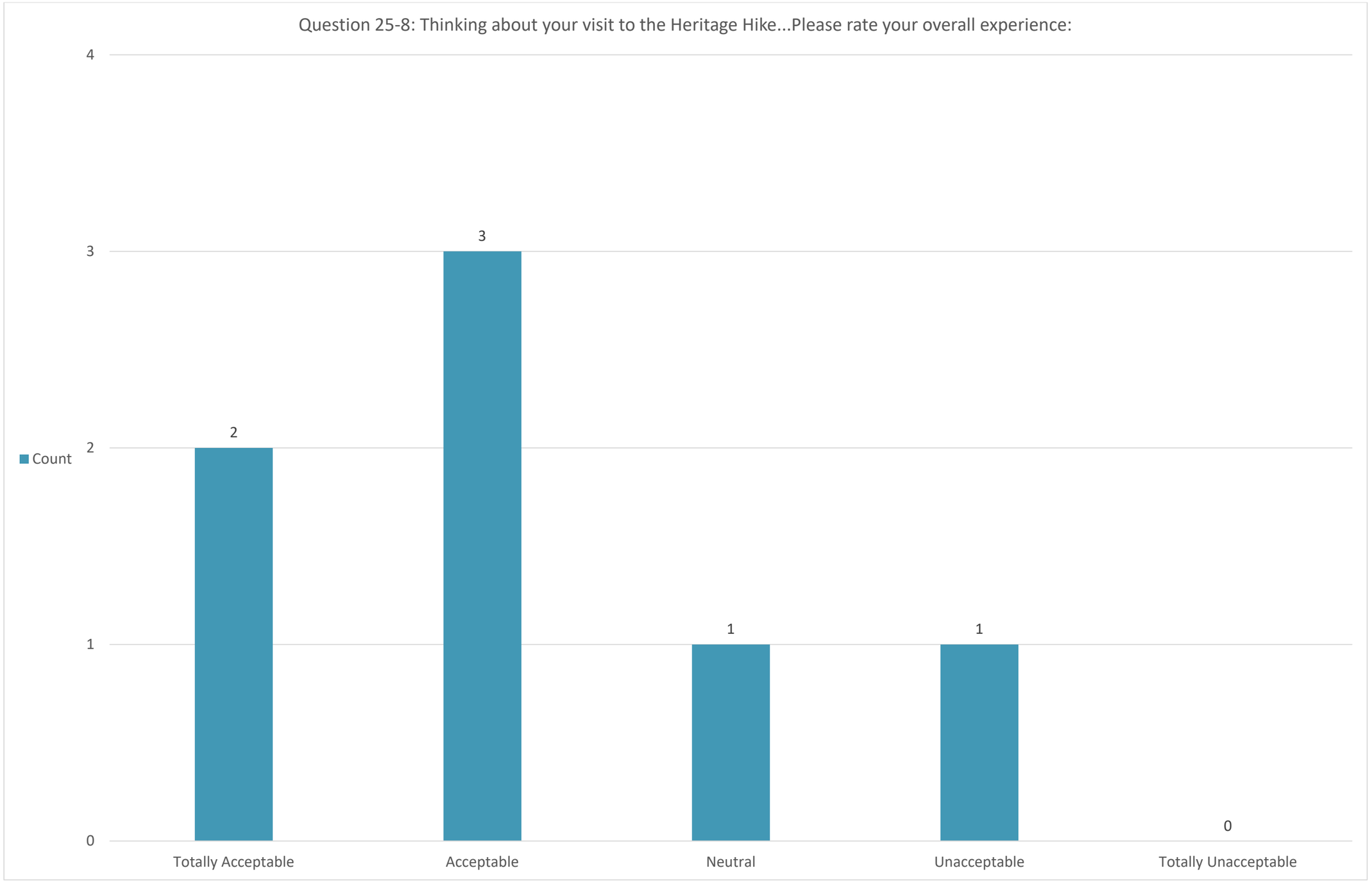

Question 25-3: Thinking about your visit to the Heritage Hike...Please rate the crowding:
6
5
4
3
2
1
0
Count
0
3
5
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

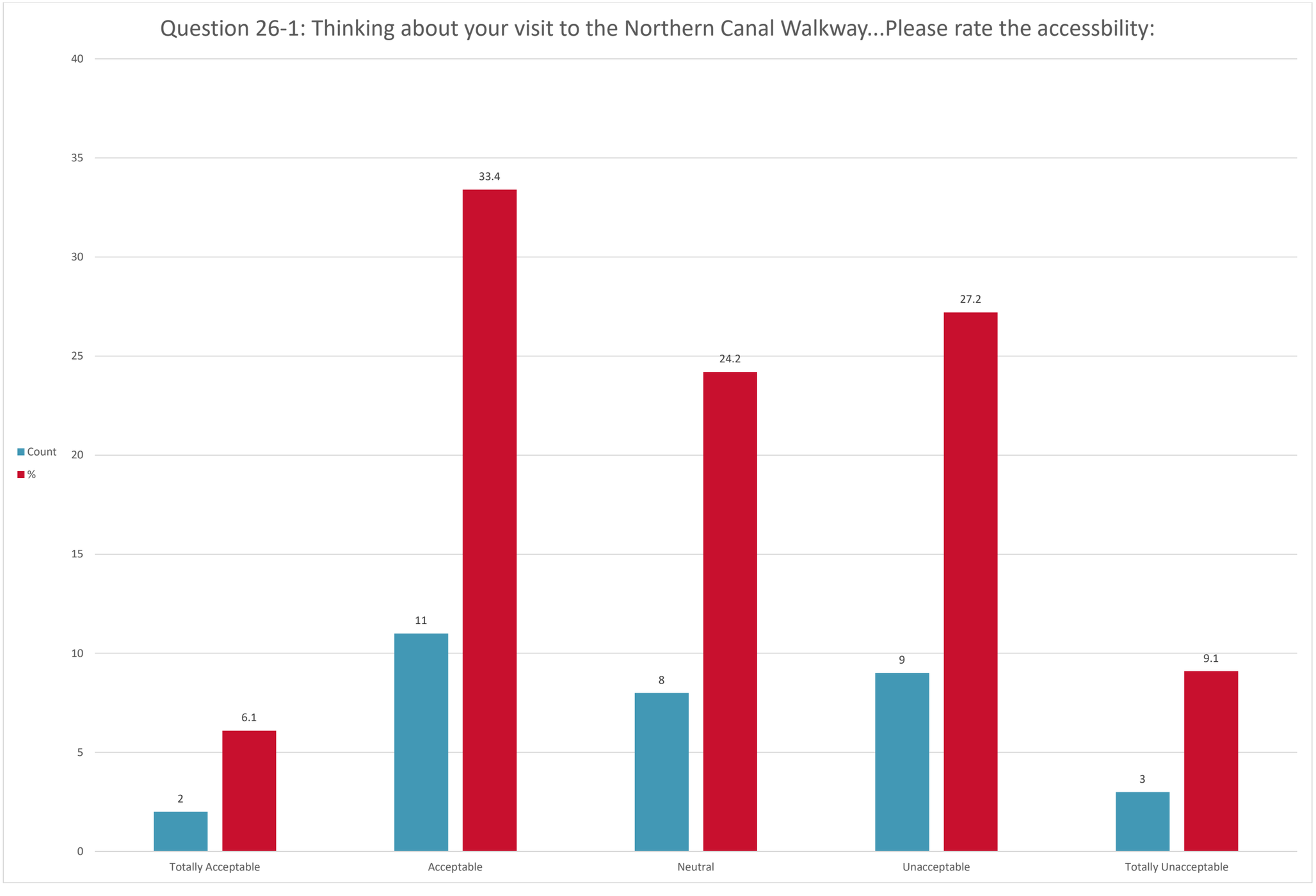

Question 25-4:Thinking about your visit to the Heritage Hike...Please rate the safety:
6
5
4
3
2
1
0
Count
5
2
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

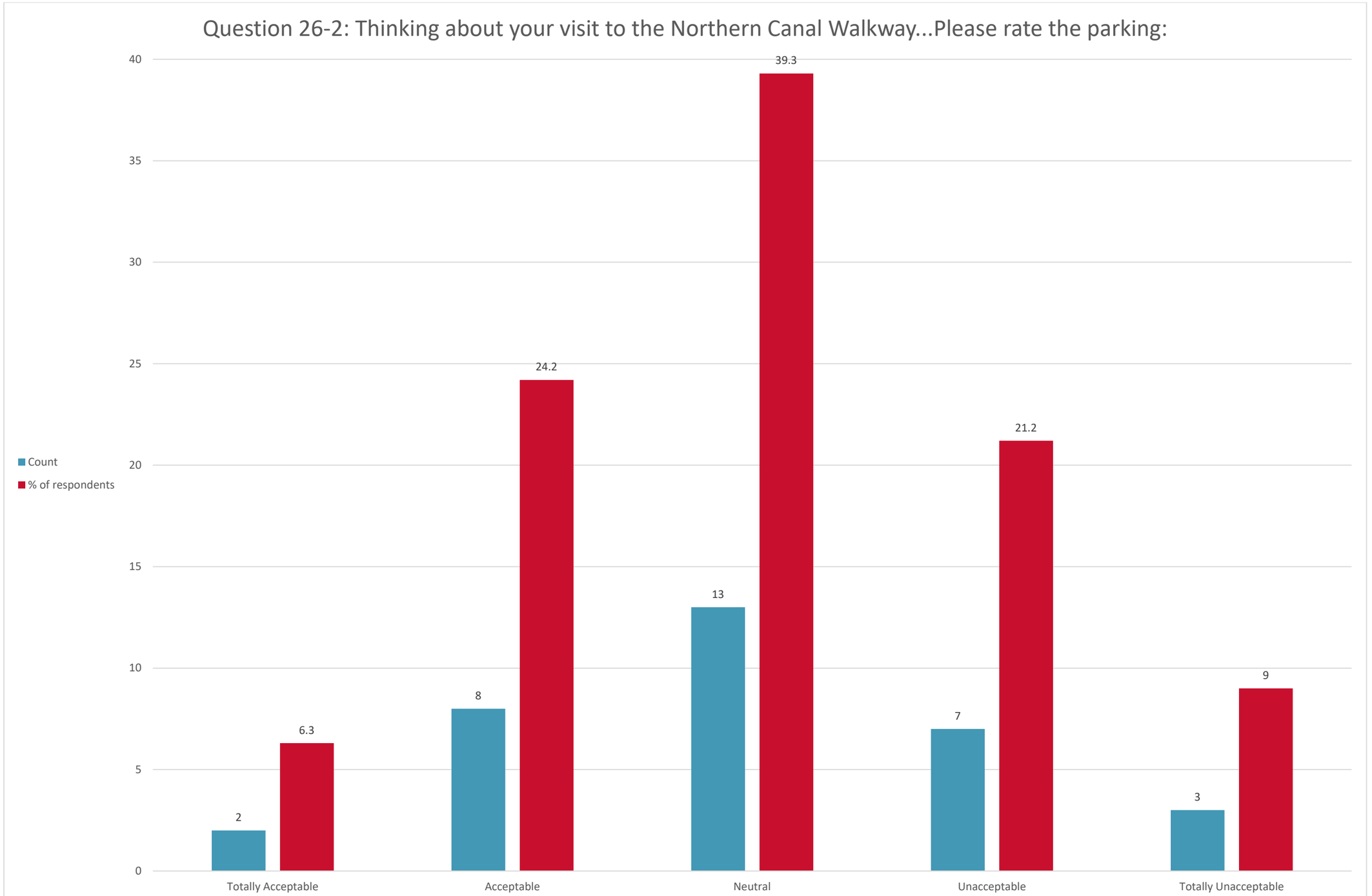

Question 25-5: Thinking about your visit to the Heritage Hike...Please rate the condition of recreation facilities:
Count
4
3
2
1
0
0
1
2
3
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

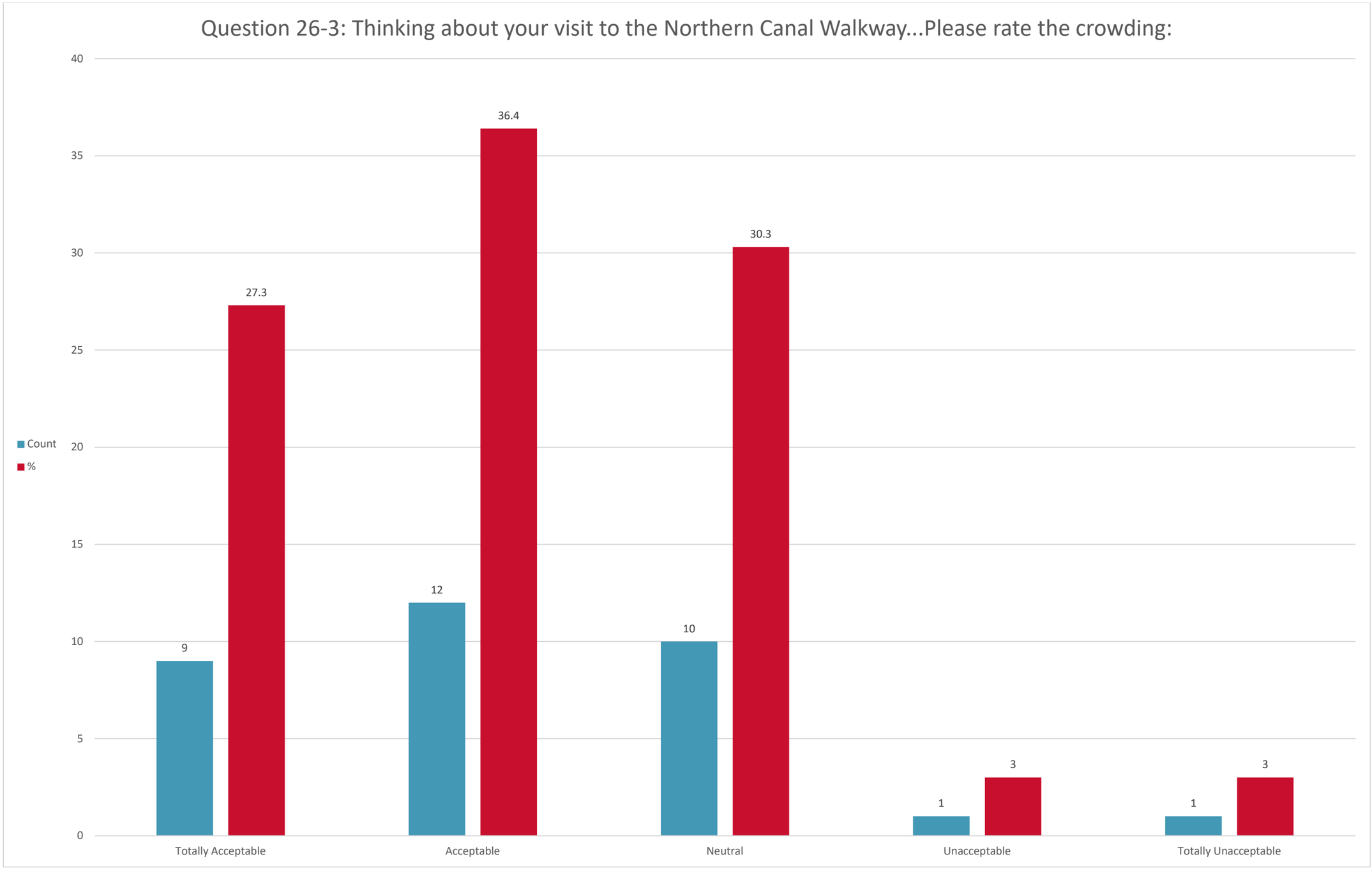

Question 25-6: Thinking about your visit to the Heritage Hike...Please rate the available amenities:
Count
4
3
2
1
0
0
3
2
1
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

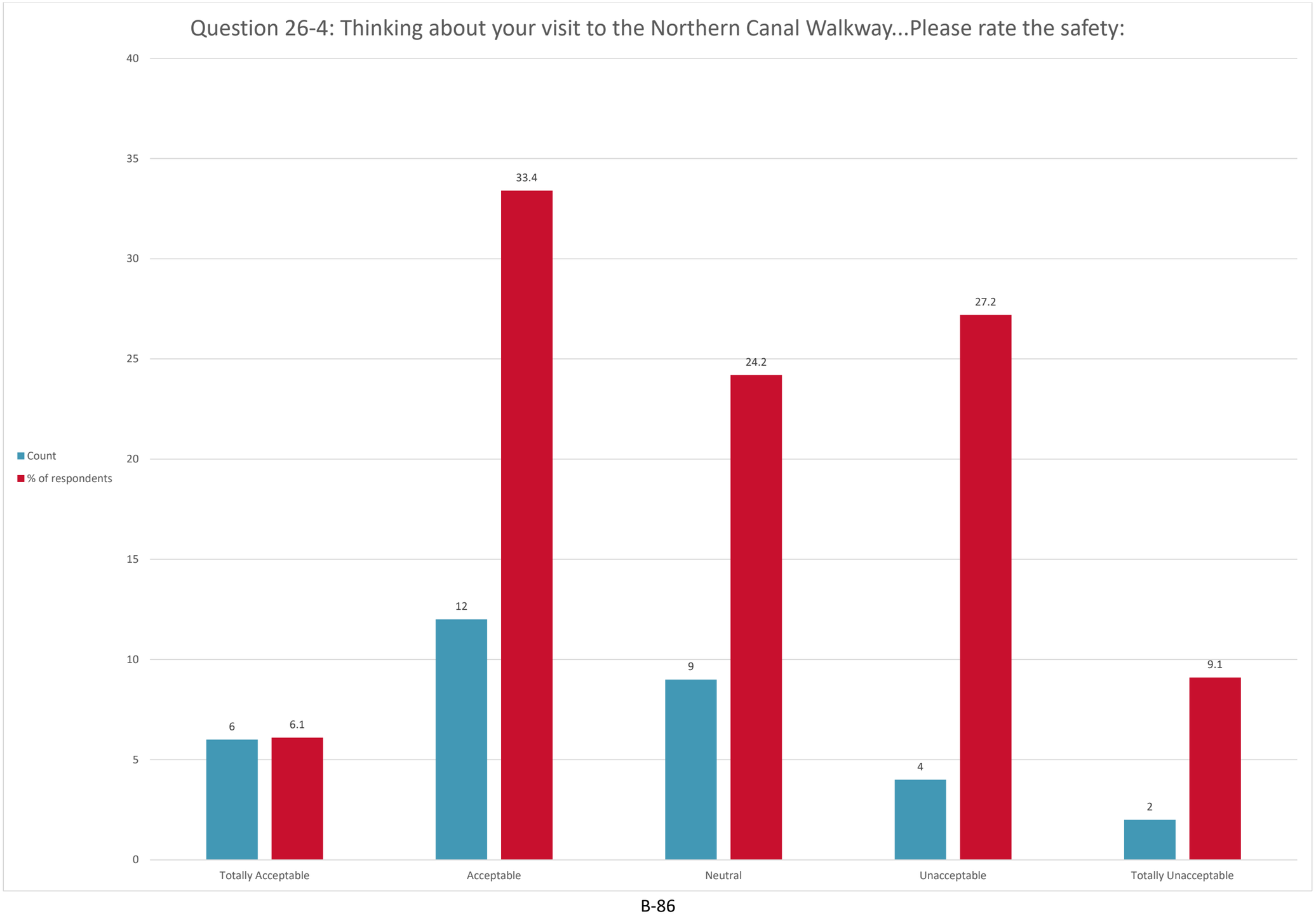

Question 25-7: Thinking about your visit to the Heritage Hike...please rate the river/canal flow:
3
2
1
0
Count
2
2
2
2
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

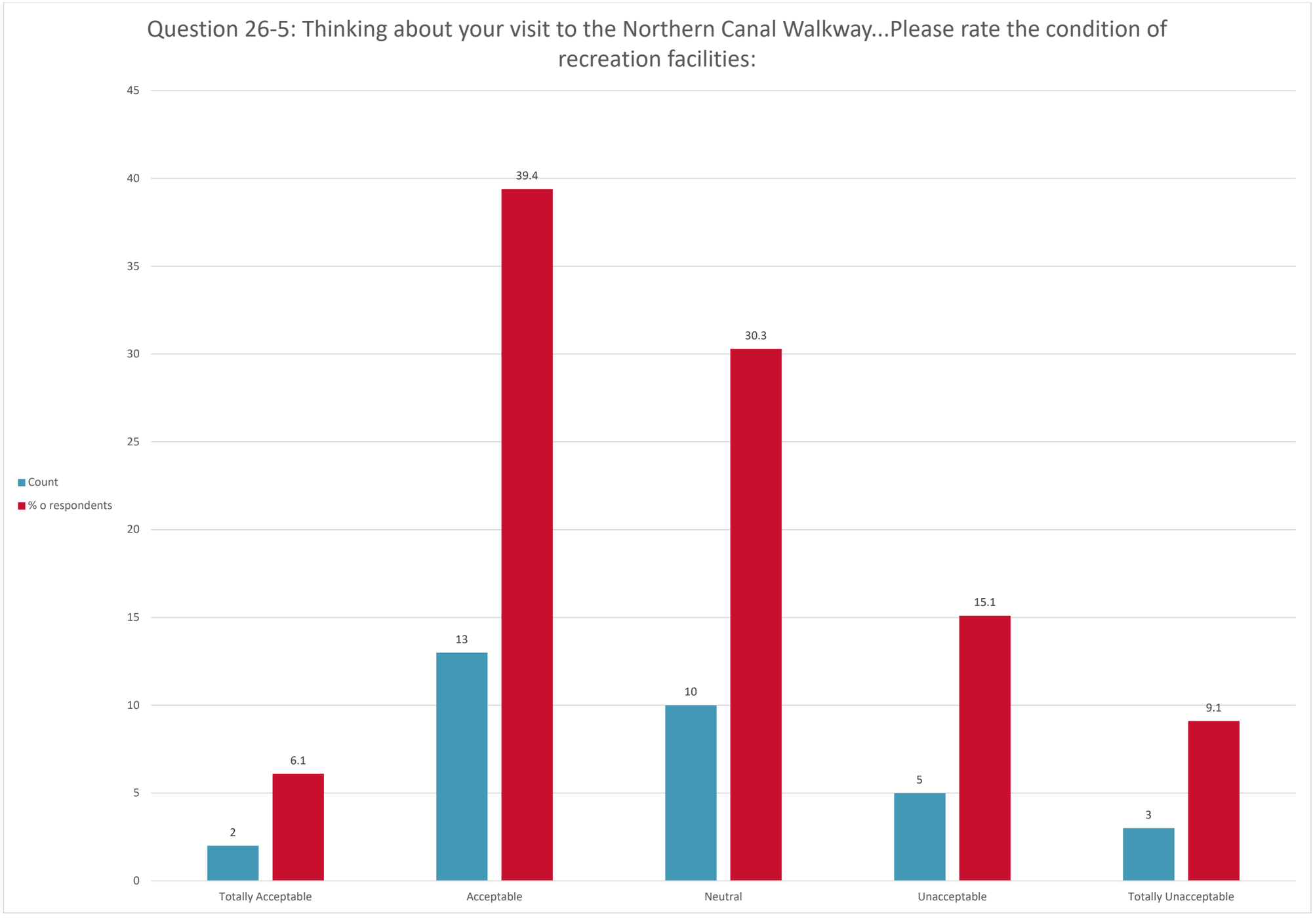

Question 25-8: Thinking about your visit to the Heritage Hike...Please rate your overall experience:
Count
4
3
2
1
0
2
3
1
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

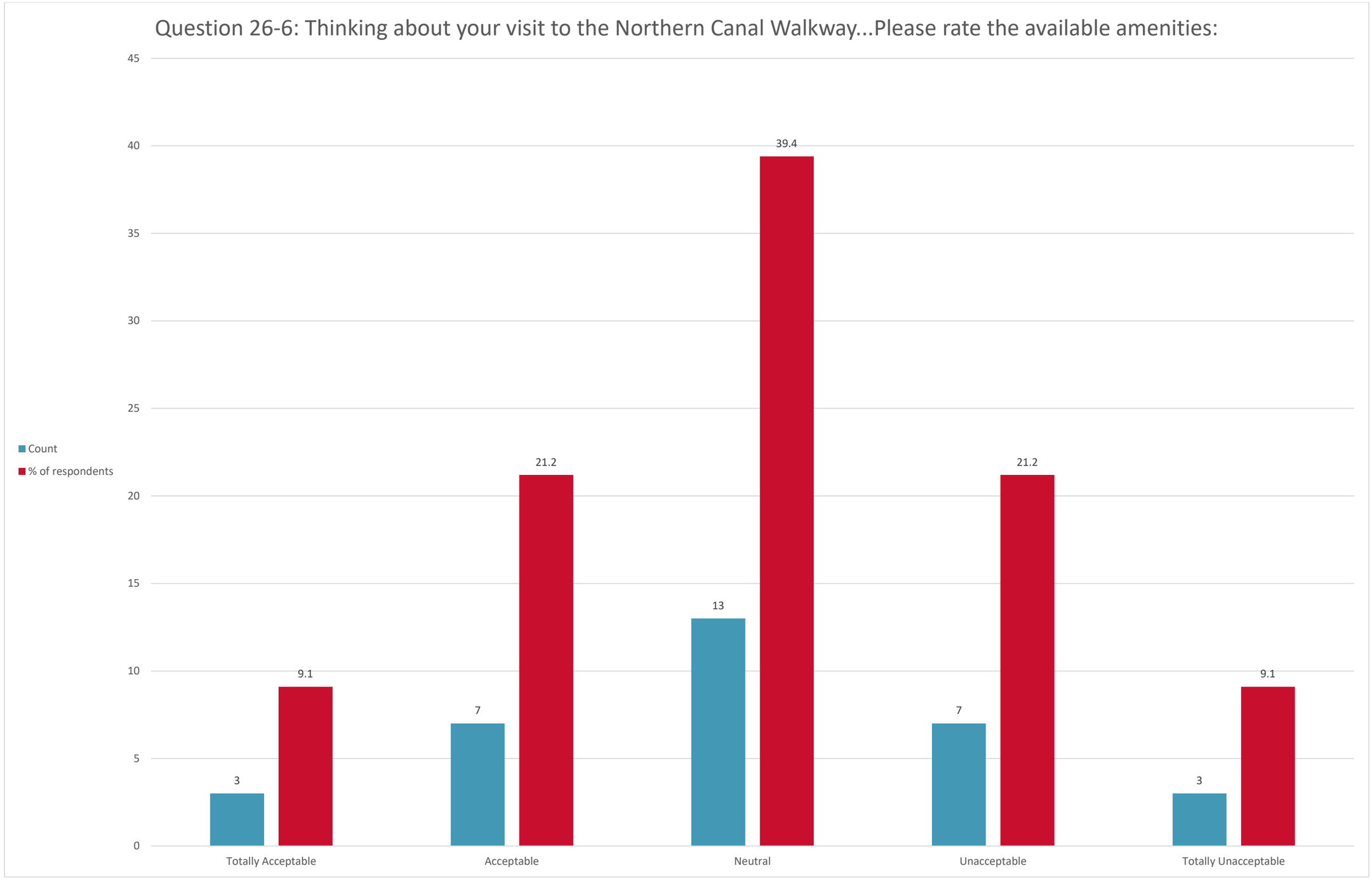

Question 26-1: Thinking about your visit to the Northern Canal Walkway...Please rate the accessbility:
Count
%
40
35
30
25
20
15
10
5
0
33.4
24.2
27.2
11
8
9
9.1
6.1
2
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

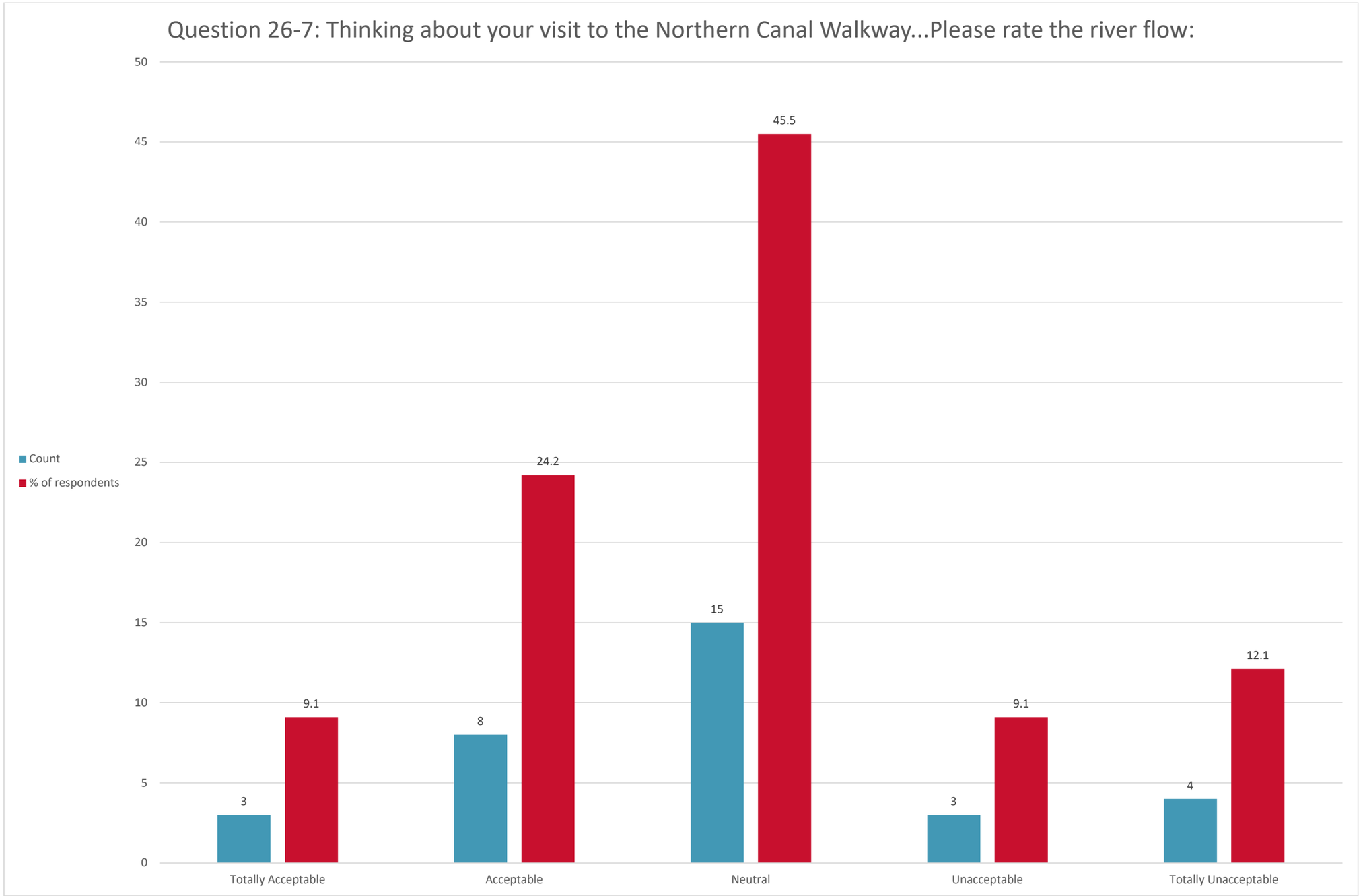

Question 26-2: Thinking about your visit to the Northern Canal Walkway...Please rate the parking:
Count
% of respondents
40
35
30
25
20
15
10
5
0
2
6.3
8
24.2
13
39.3
7
21.2
3
9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

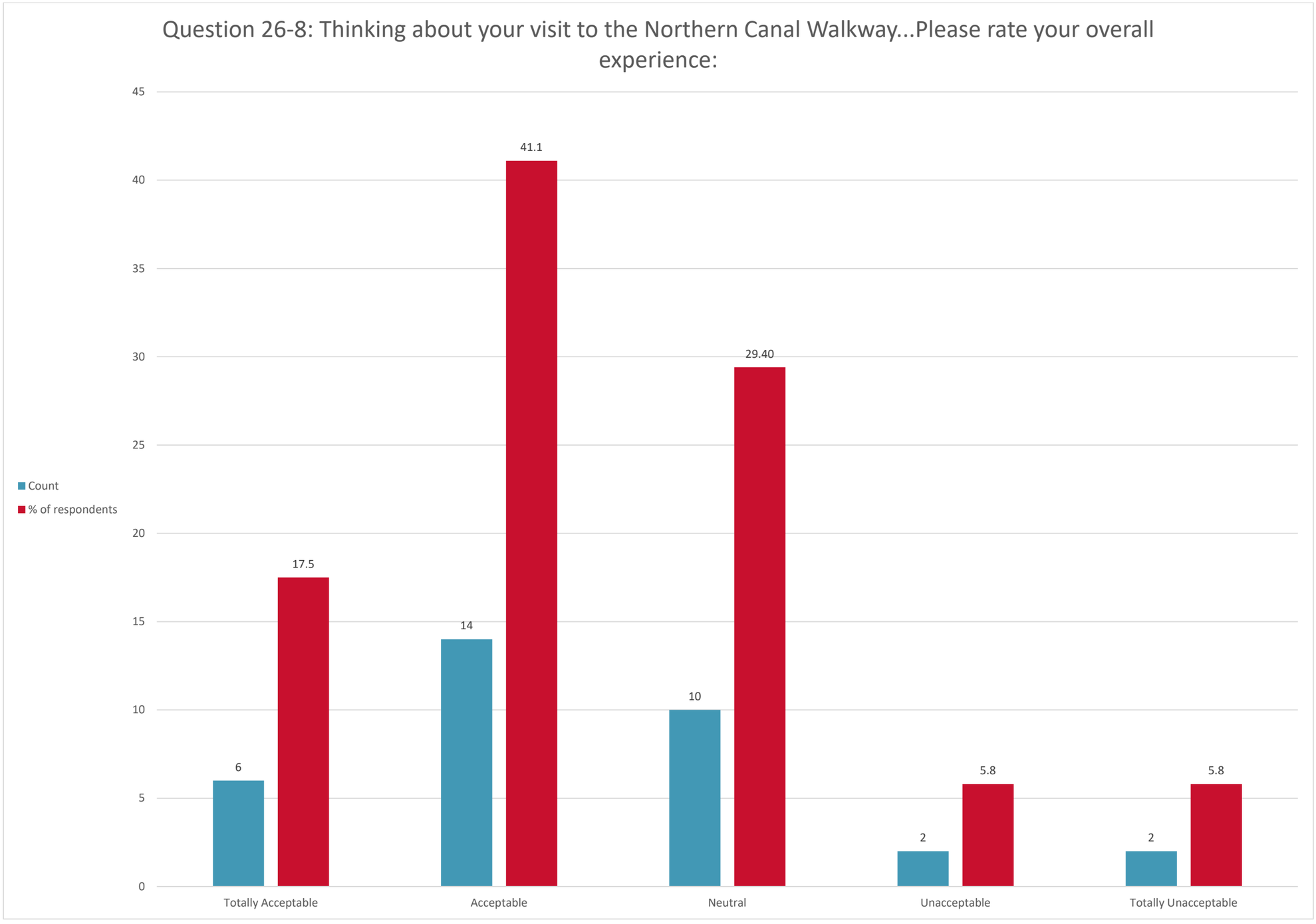

Question 26-3: Thinking about your visit to the Northern Canal Walkway...Please rate the crowding:
Count
%
40
35
30
25
20
15
10
5
0
27.3
36.4
30.3
9
12
10
1
3
1
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

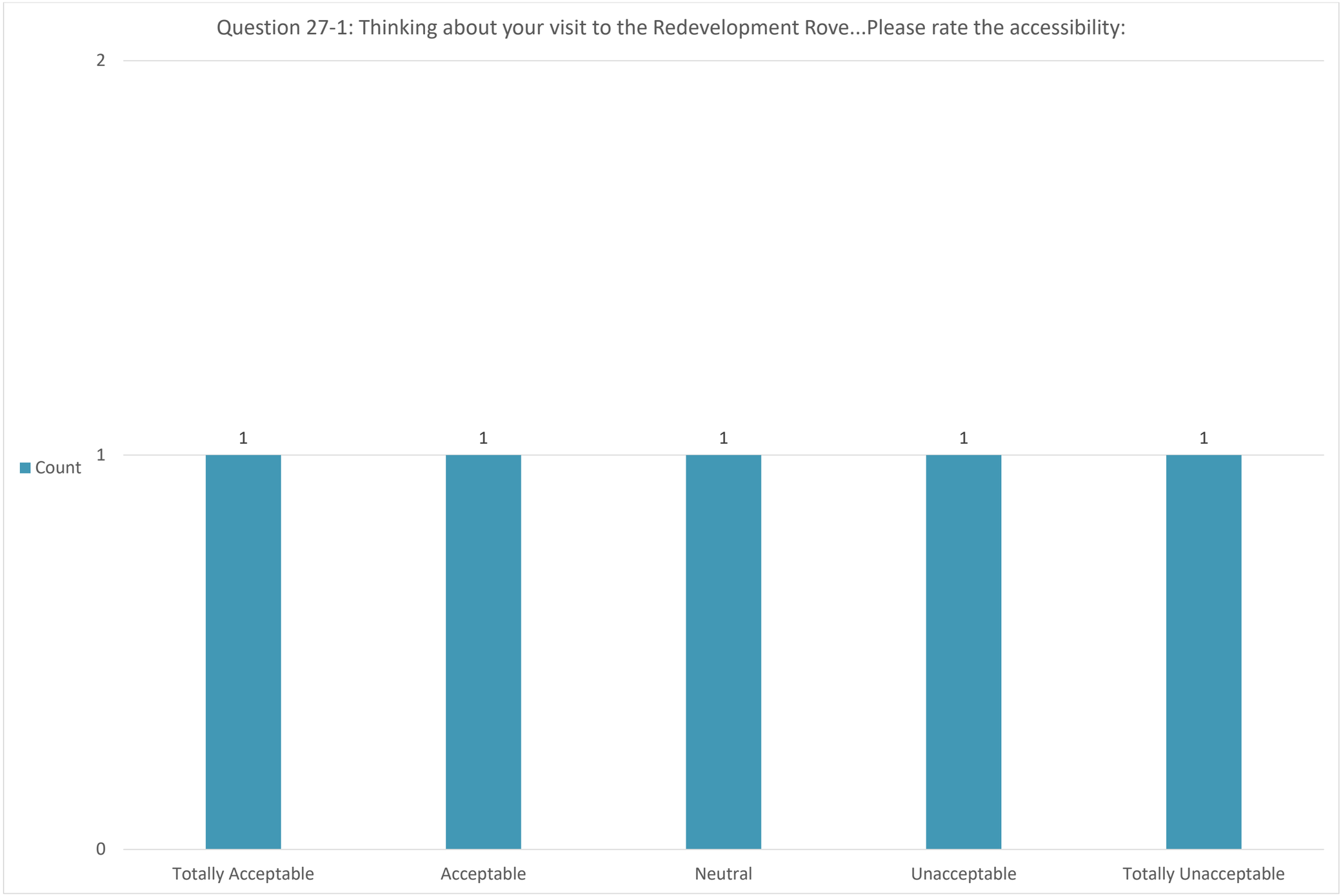

Question 26-4: Thinking about your visit to the Northern Canal Walkway...Please rate the safety:
Count
% of respondents
40
35
30
25
20
15
10
5
0
6
6.1
12
33.4
9
24.2
4
27.2
2
9.1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

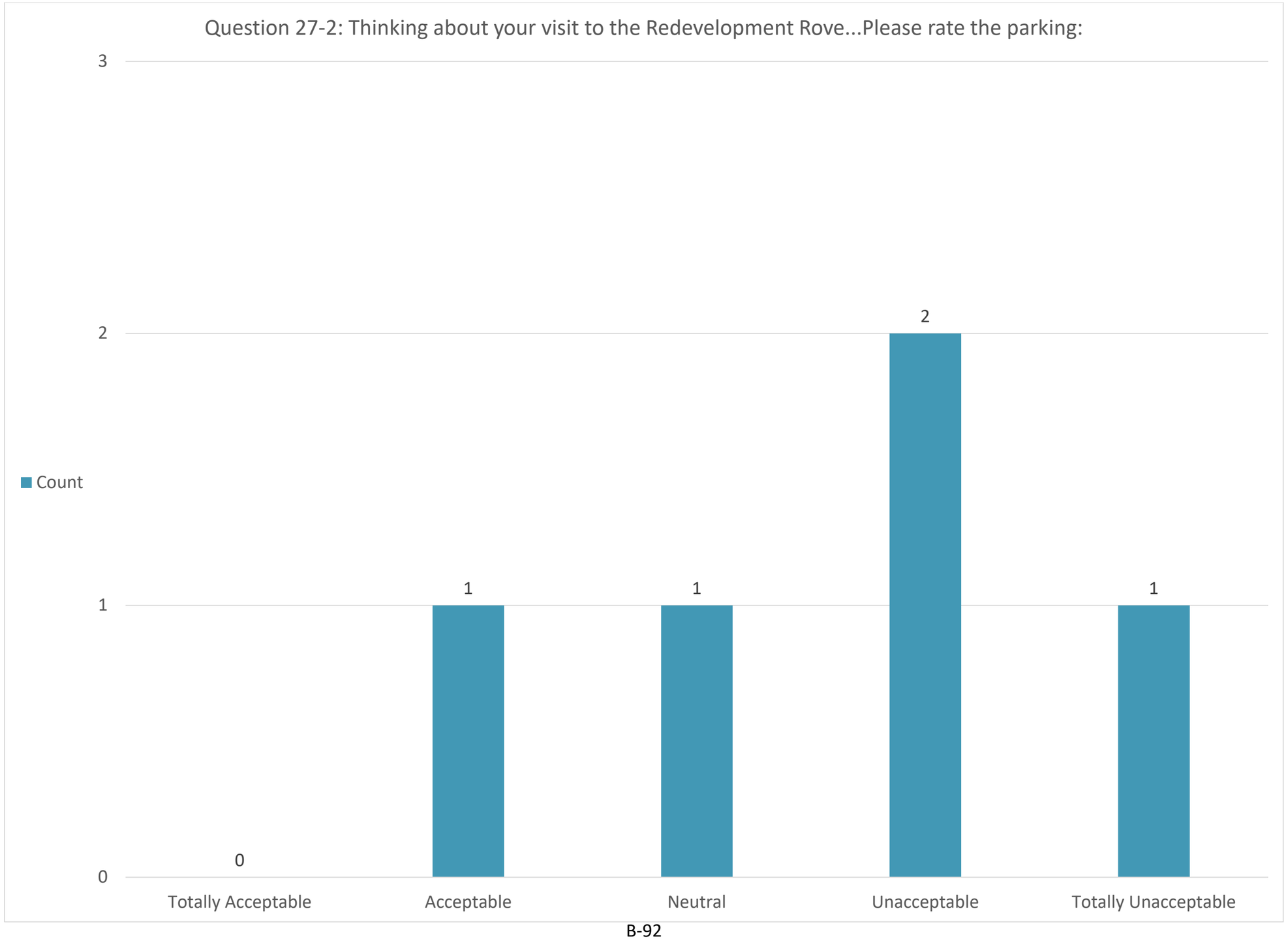

Question 26-5: Thinking about your visit to the Northern Canal Walkway...Please rate the condition of recreation facilities:
45
40
35
30
25
20
15
10
5
0
Count
% o respondents
39.4
30.3
15.1
13
10
9.1
6.1
5
3
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

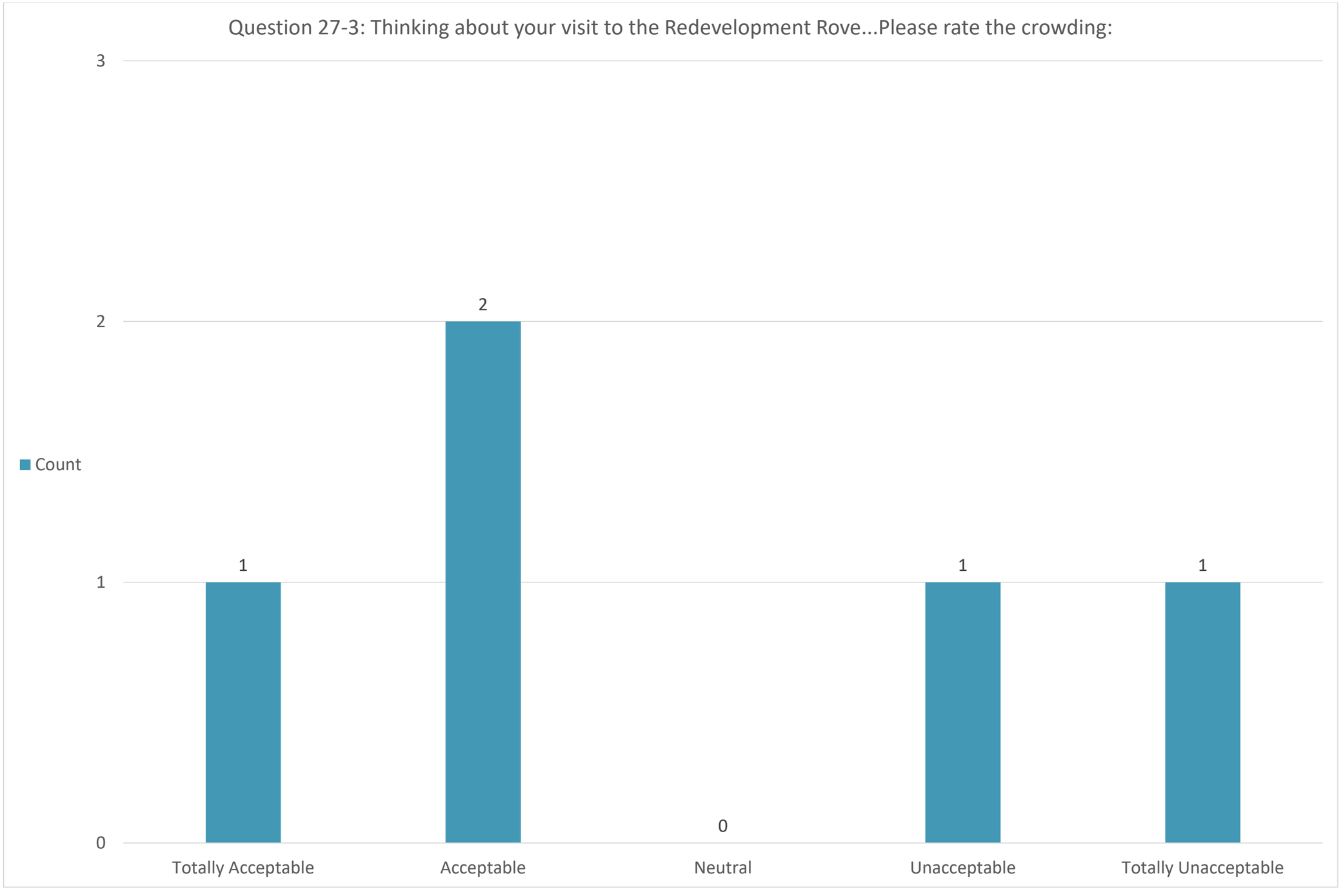

Question 26-6: Thinking about your visit to the Northern Canal Walkway...Please rate the available amenities:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
39.4
21.2
21.2
13
9.1
9.1
7
7
3
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

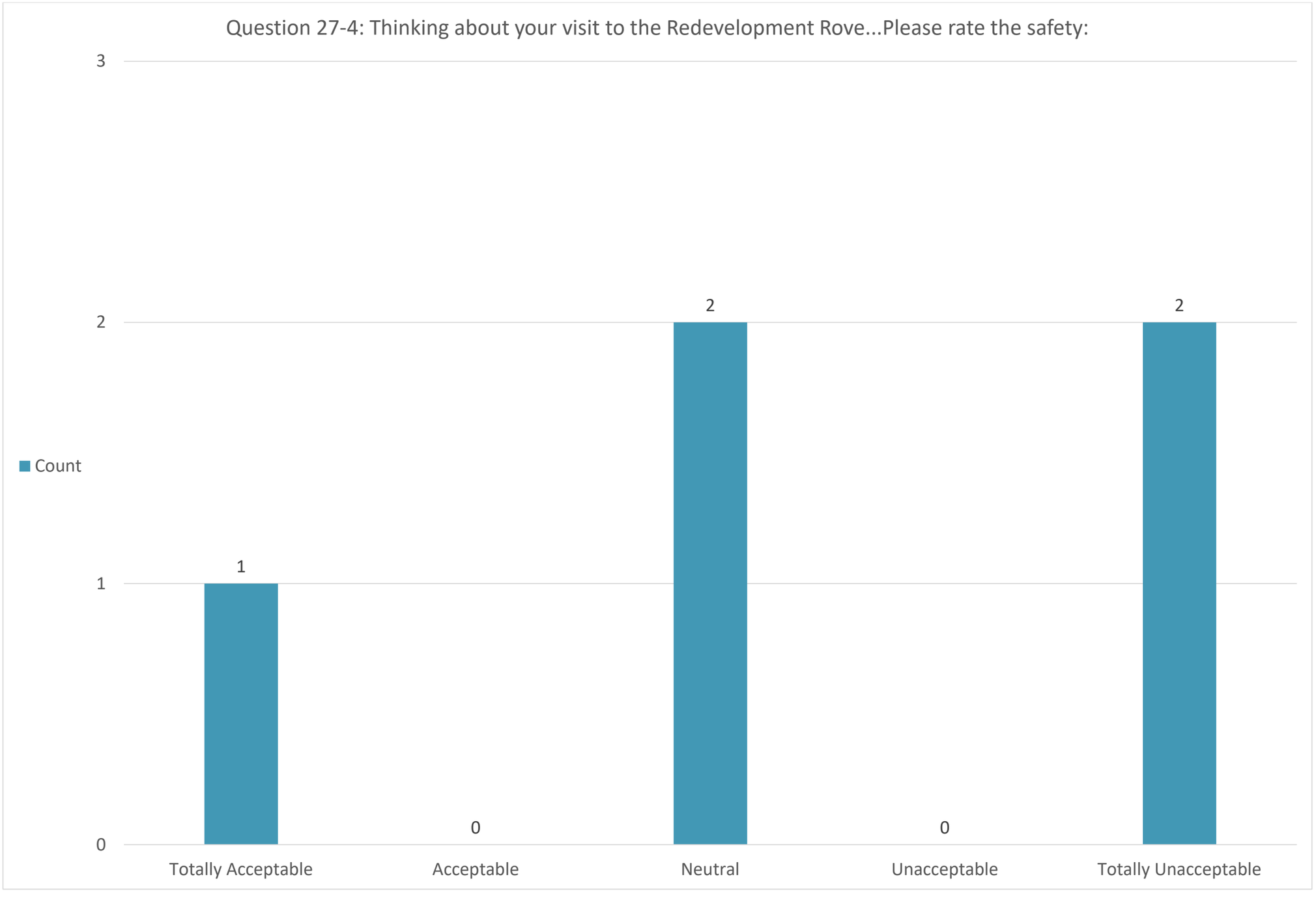

Question 26-7: Thinking about your visit to the Northern Canal Walkway...Please rate the river flow:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
3
9.1
8
24.2
15
45.5
3
9.1
4
12.1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

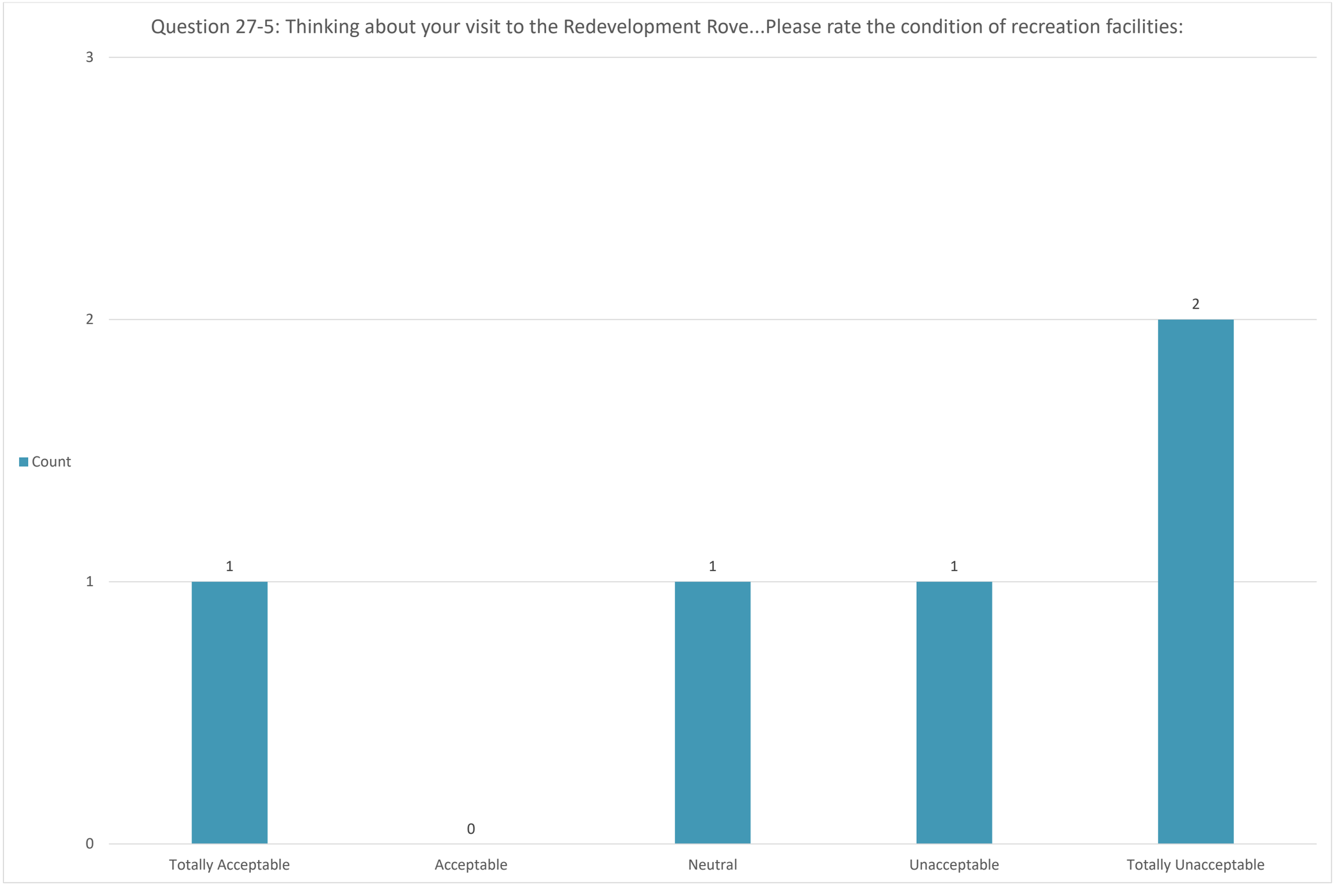

Question 26-8: Thinking about your visit to the Northern Canal Walkway...Please rate your overall experience:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
41.1
29.40
17.5
14
10
6
5.8
5.8
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

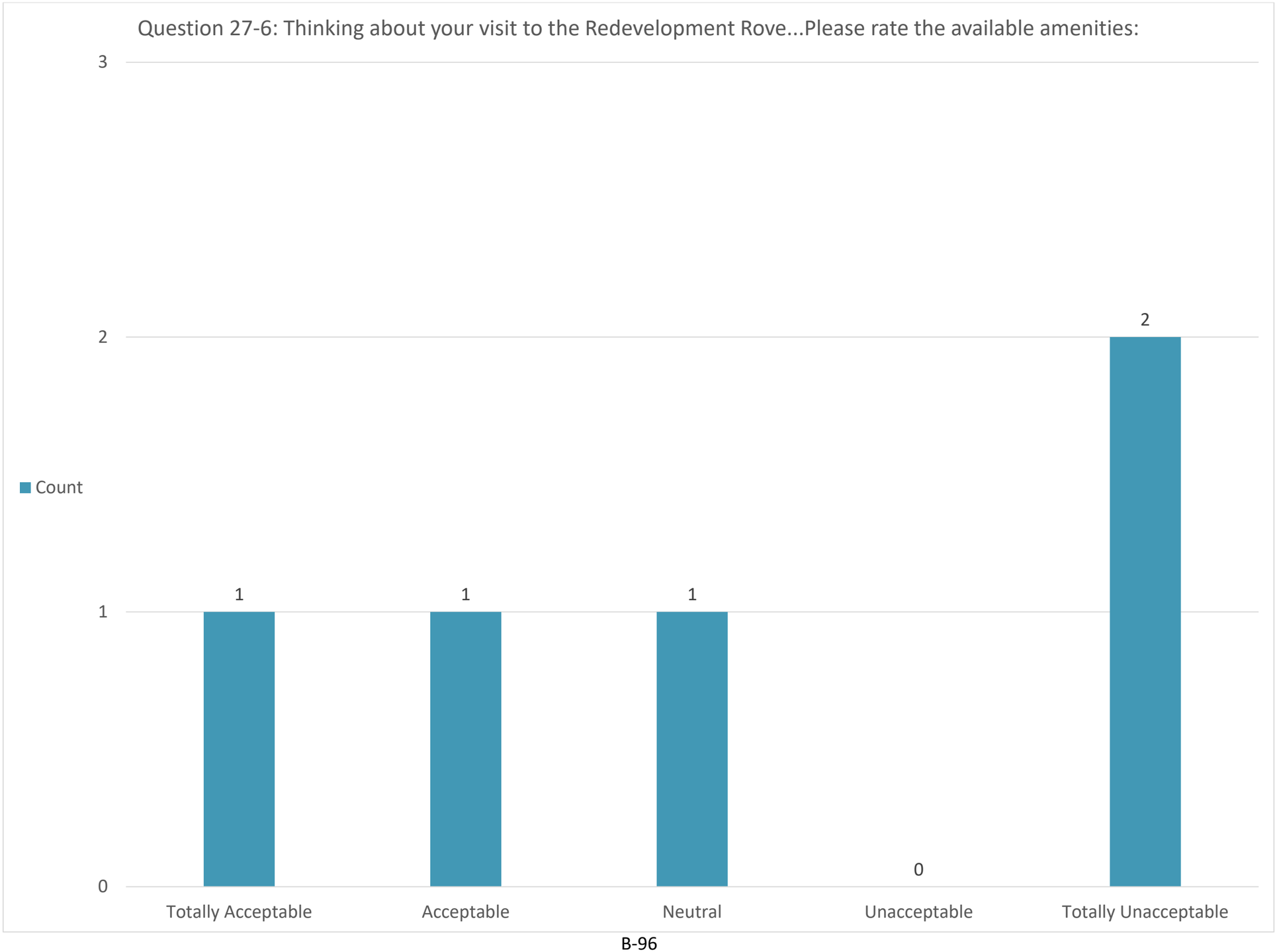

Question 27-1: Thinking about your visit to the Redevelopment Rove...Please rate the accessibility:
2
1
0
Count
1
1
1
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

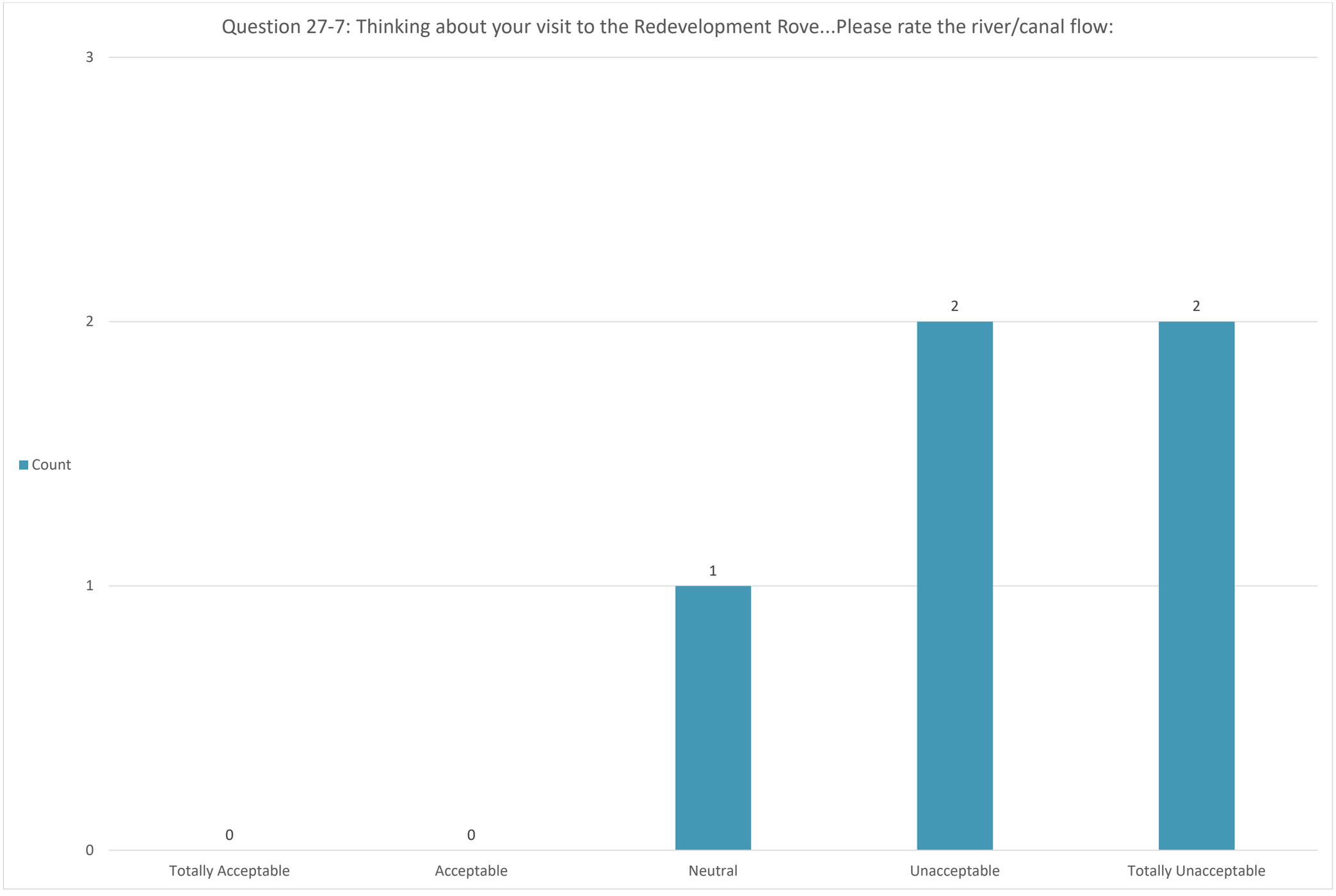

Question 27-2: Thinking about your visit to the Redevelopment Rove...Please rate the parking:
3
2
1
0
Count
0
1
1
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

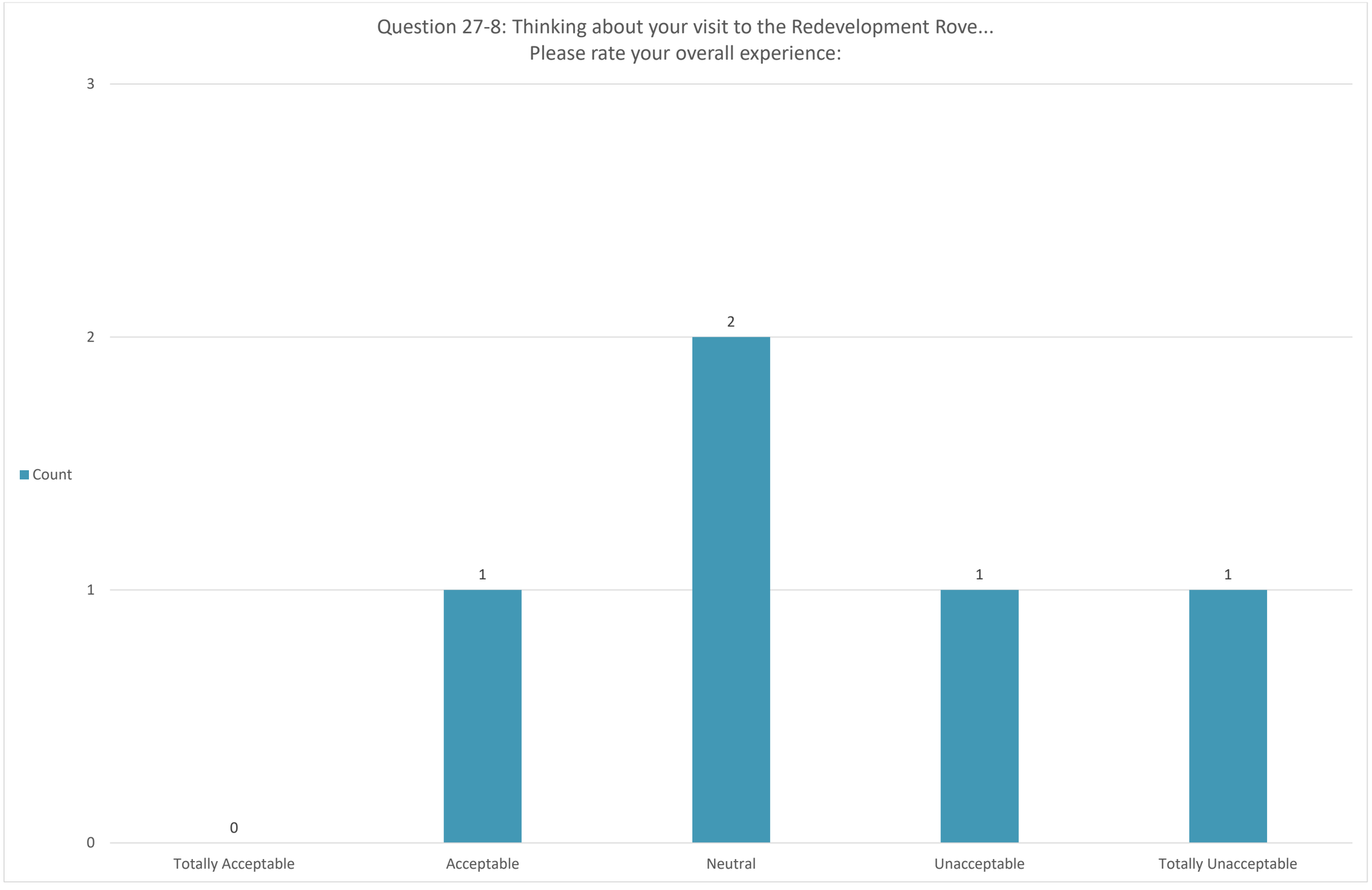

Question 27-3: Thinking about your visit to the Redevelopment Rove...Please rate the crowding:
3
2
1
0
Count
1
2
0
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

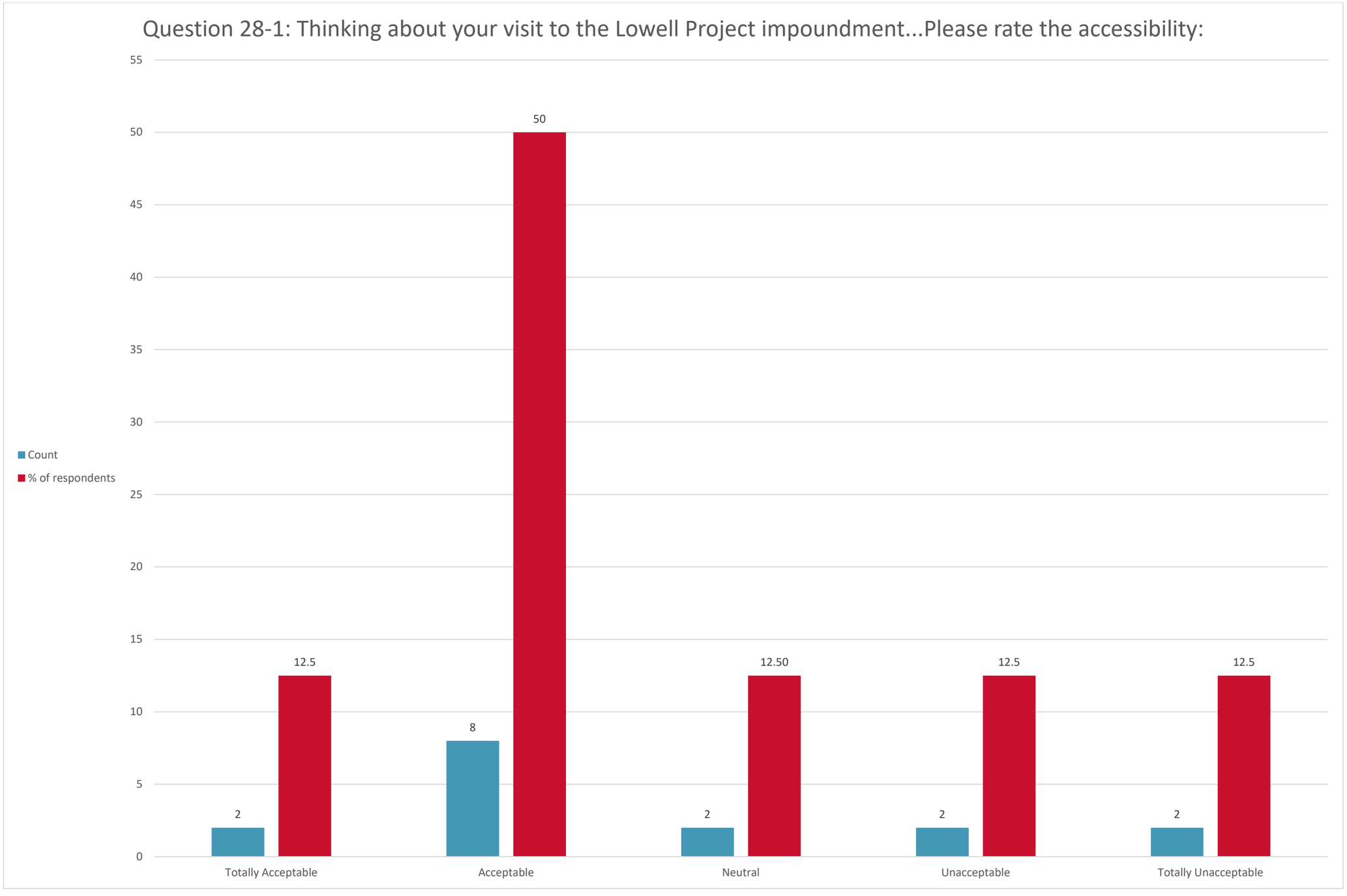

Question 27-4: Thinking about your visit to the Redevelopment Rove...Please rate the safety:
3
2
1
0
Count
1
0
2
0
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

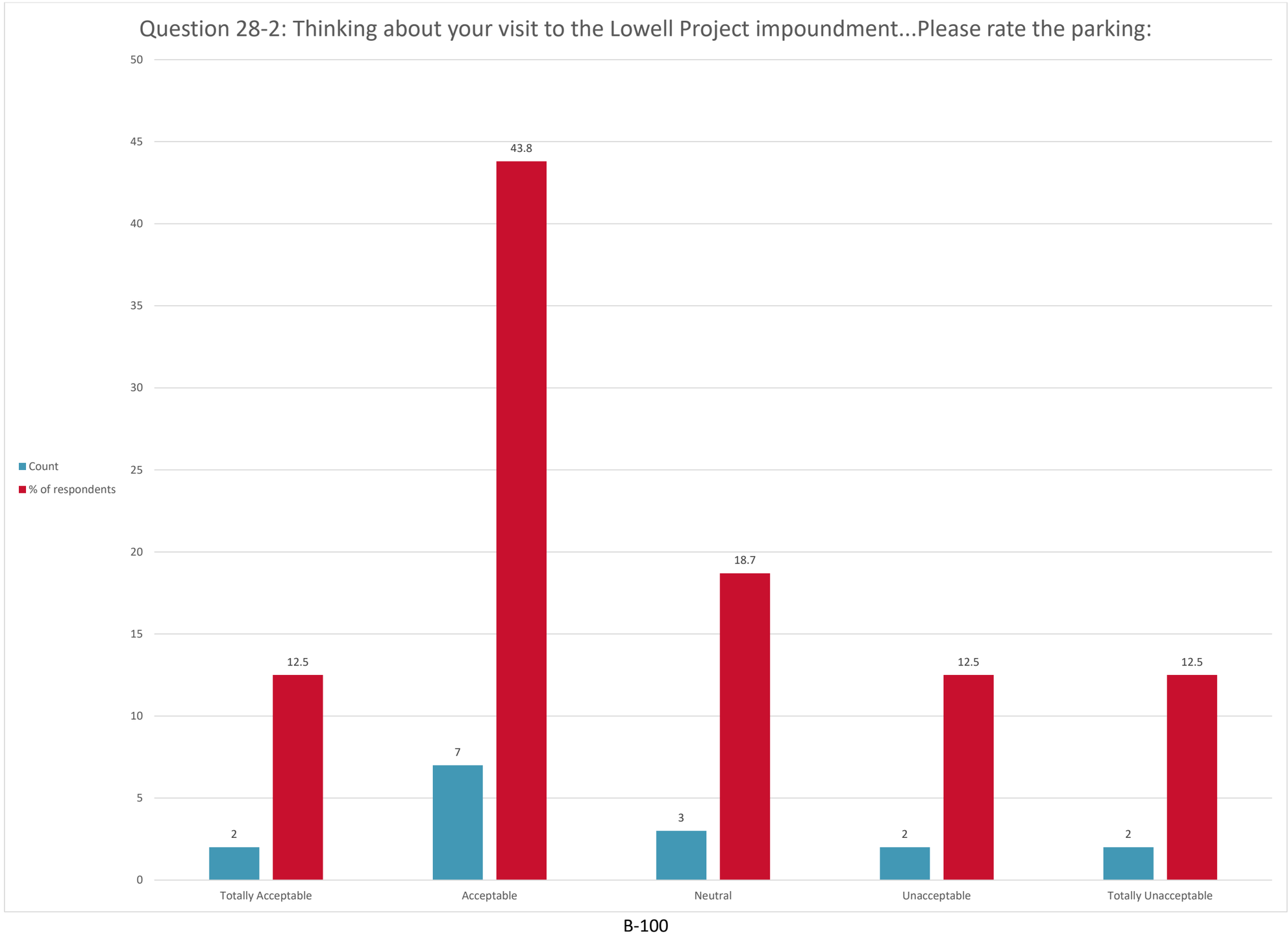

Question 27-5: Thinking about your visit to the Redevelopment Rove...Please rate the condition of recreation facilities:
3
2
1
0
Count
1
0
1
1
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

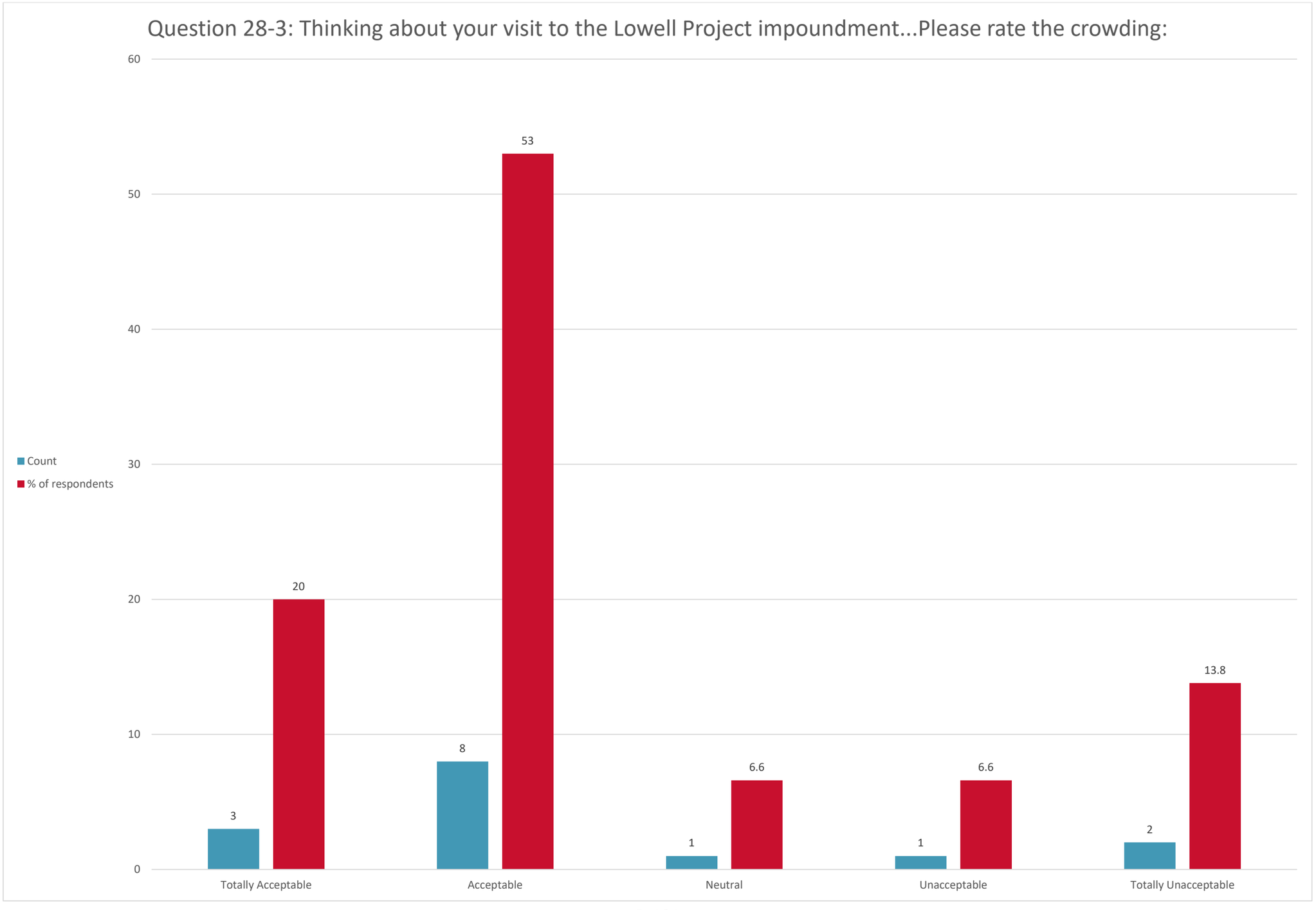

Question 27-6: Thinking about your visit to the Redevelopment Rove...Please rate the available amenities:
3
2
1
0
Count
1
1
1
0
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

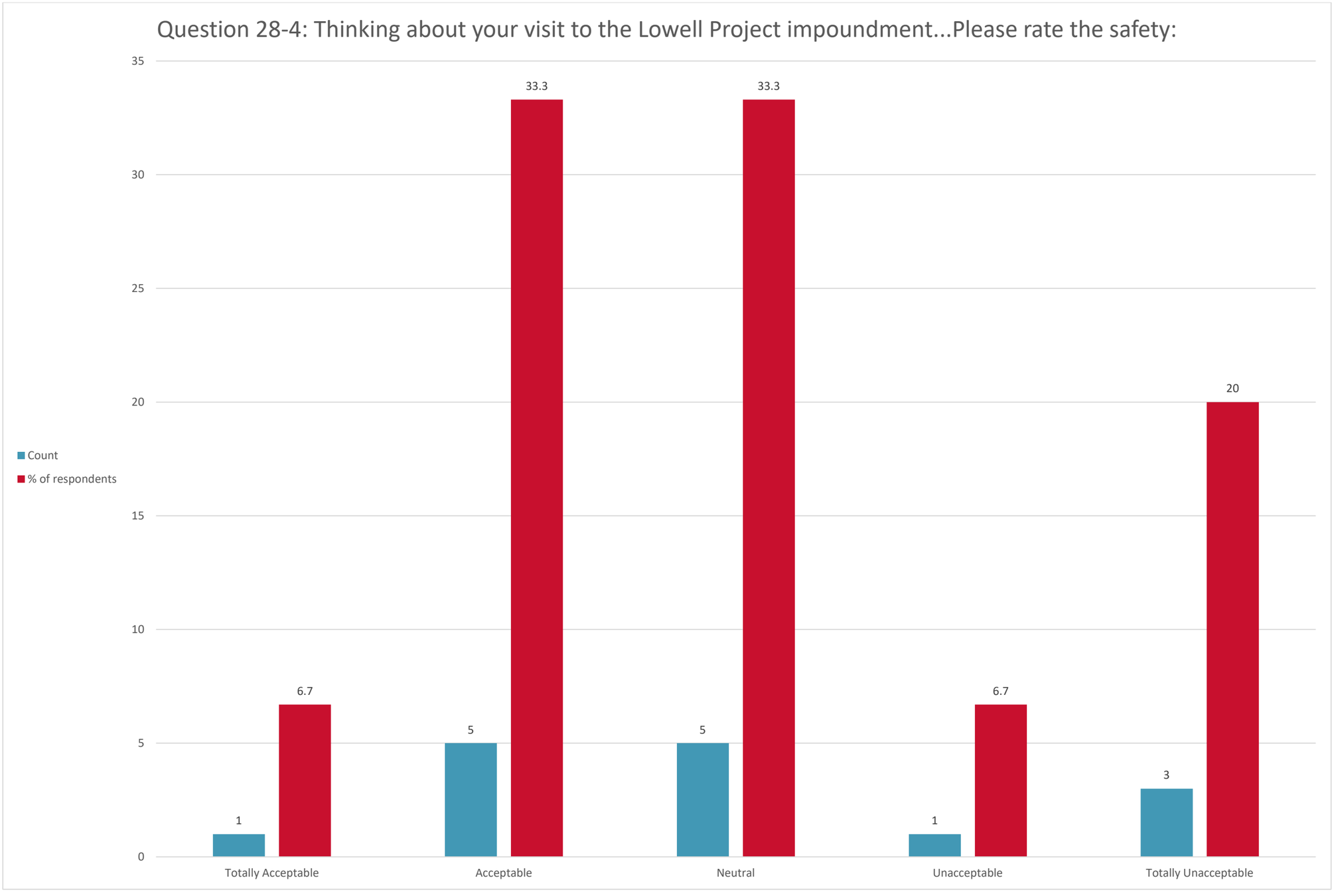

Question 27-7: Thinking about your visit to the Redevelopment Rove...Please rate the river/canal flow:
3
2
1
0
Count
0
0
1
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

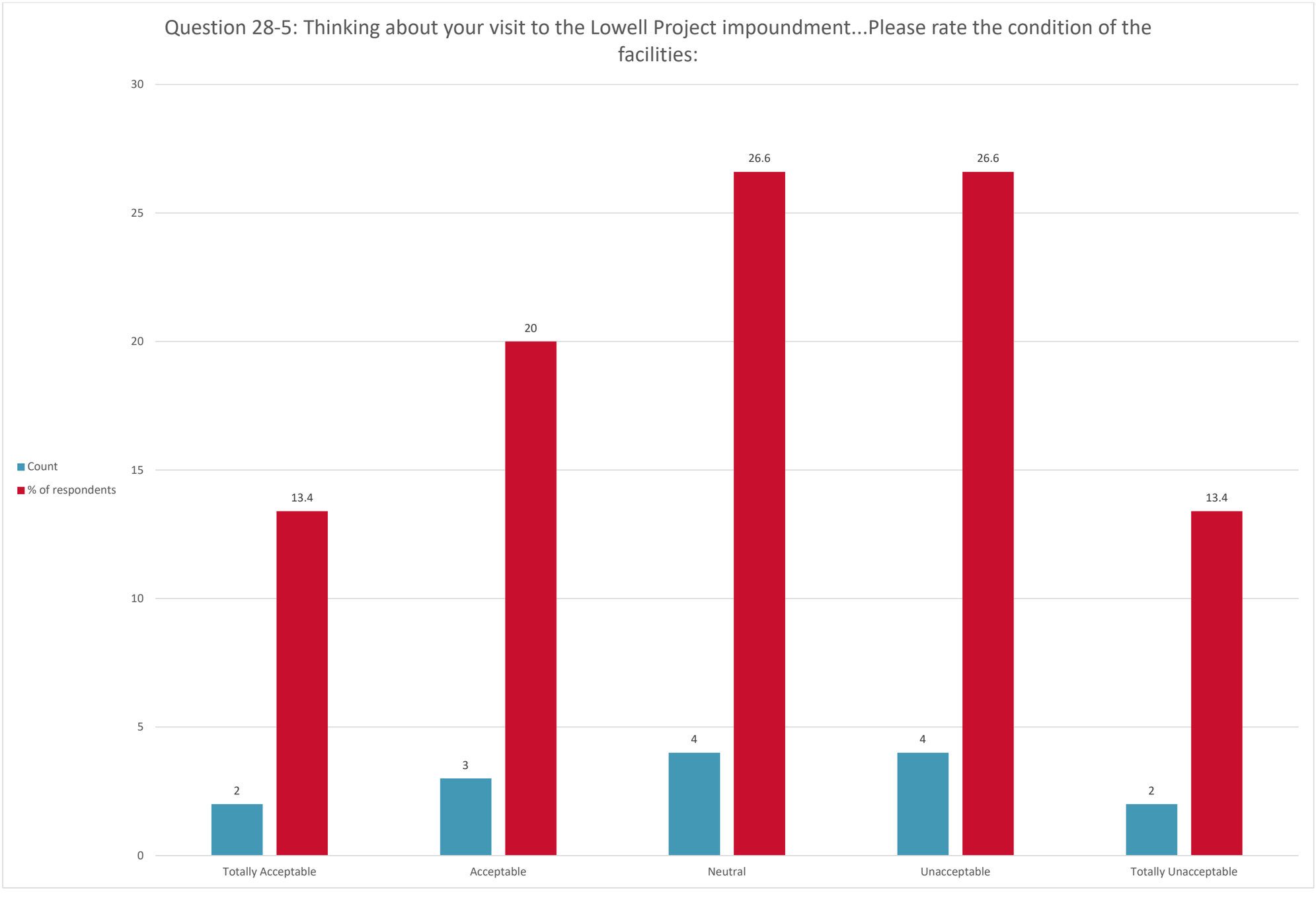

Question 27-8: Thinking about your visit to the Redevelopment Rove...
Please rate your overall experience:
3
2
1
0
Count
0
1
2
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

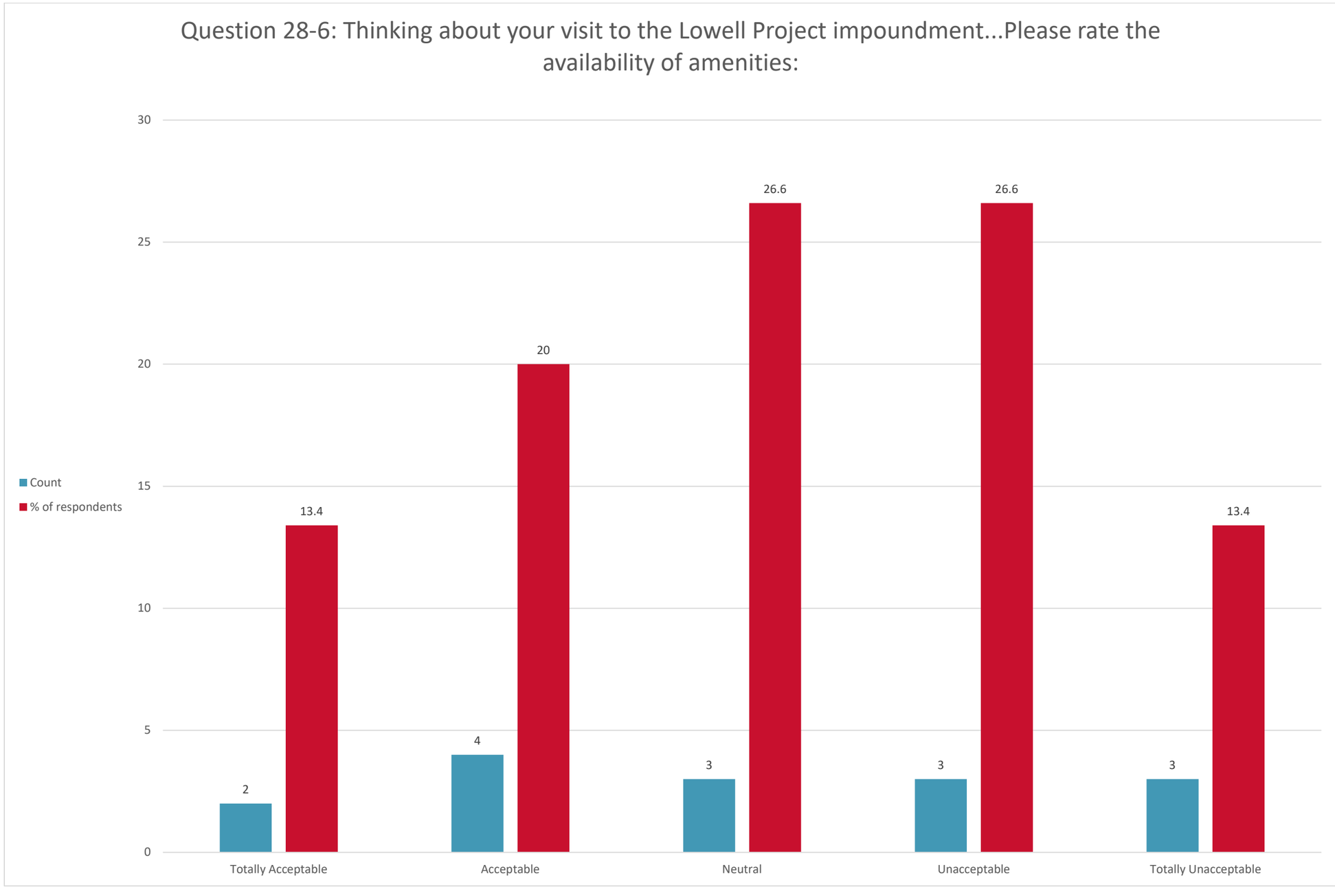

Question 28-1: Thinking about your visit to the Lowell Project impoundment...Please rate the accessibility:
55
50
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
50
12.5
8
12.50
2
2
2
12.5
12.5
12.5
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

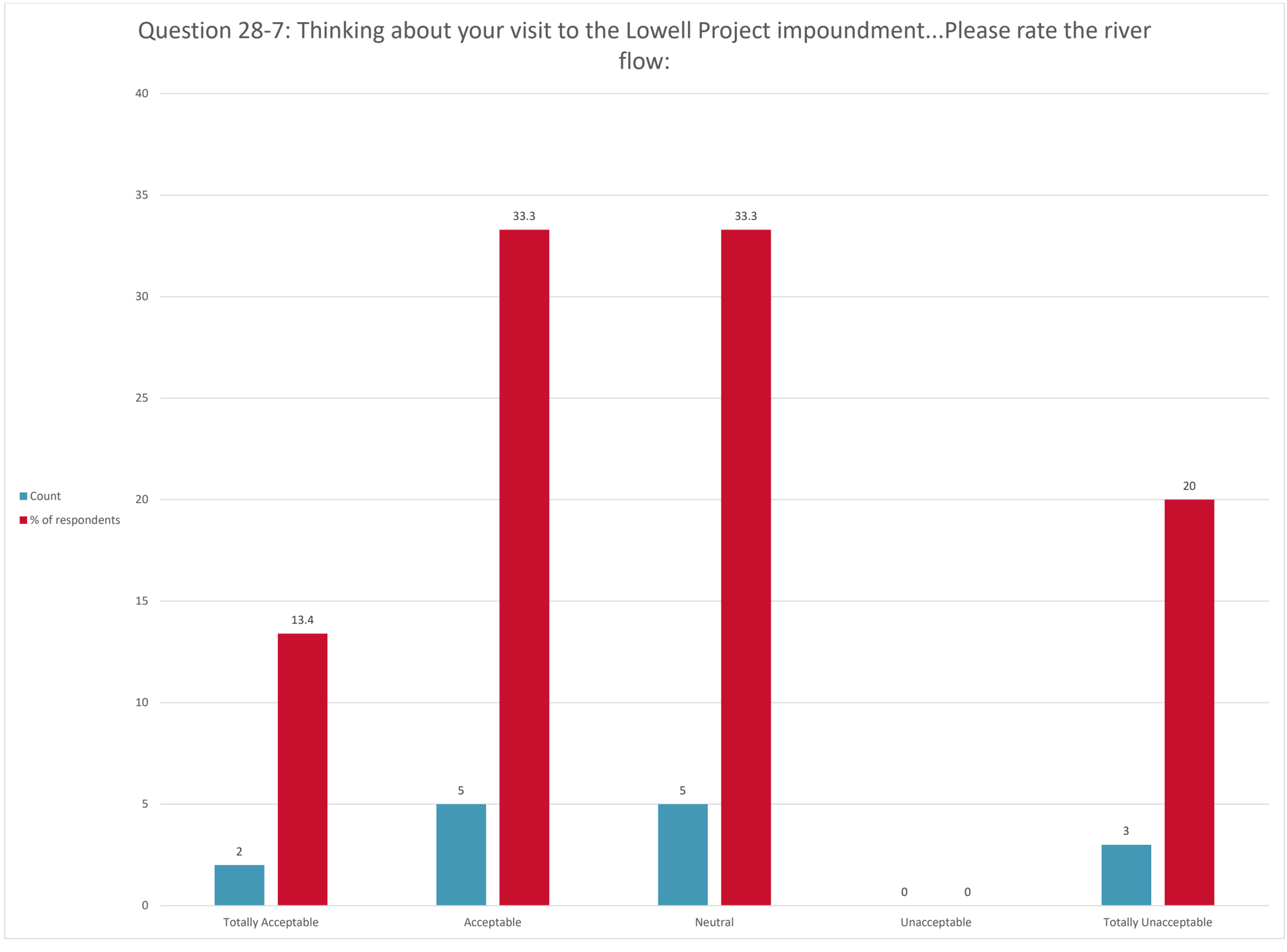

Question 28-2: Thinking about your visit to the Lowell Project impoundment...Please rate the parking:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
43.8
12.5
18.7
12.5
12.5
2
7
3
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

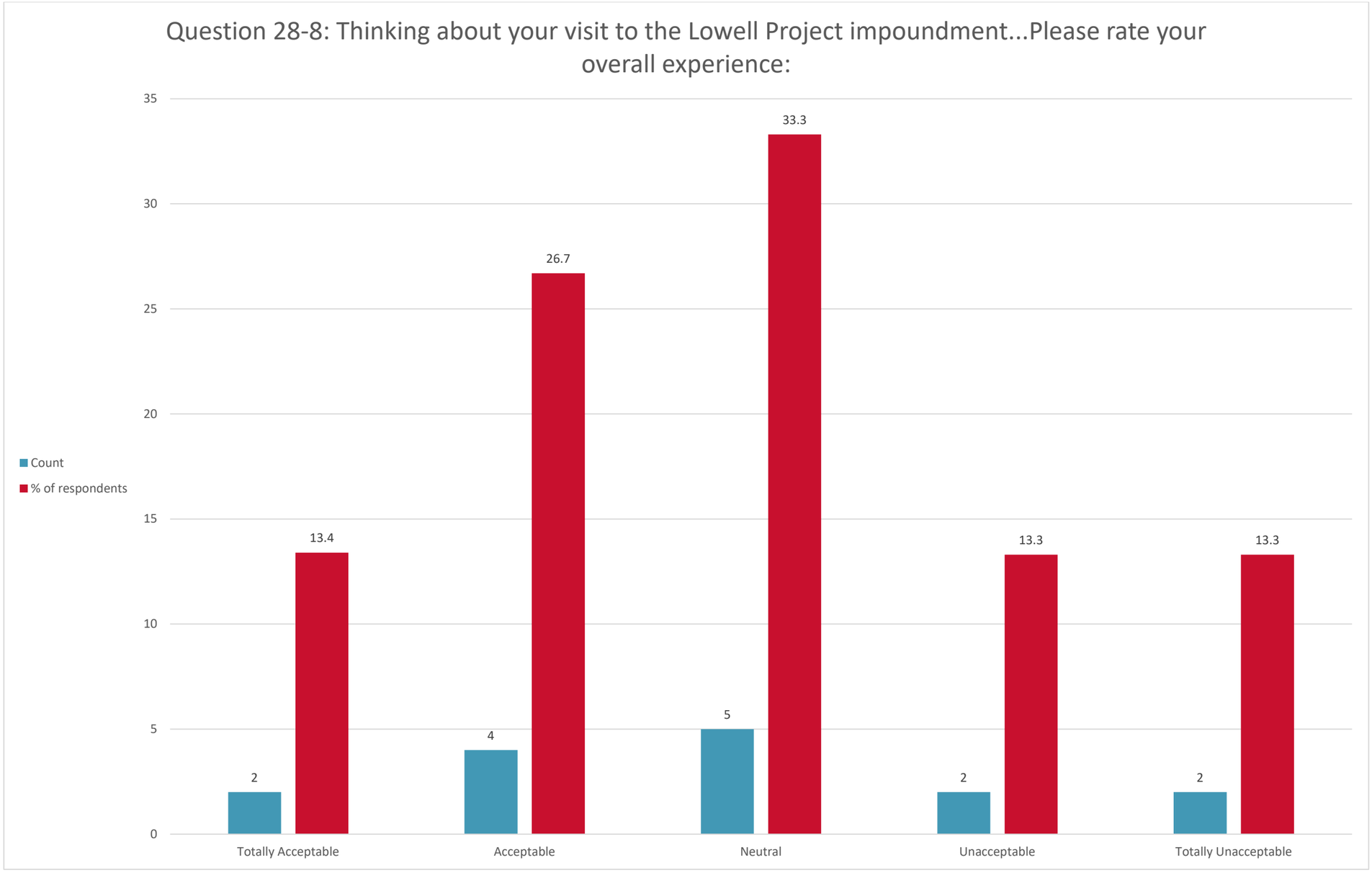

Question 28-3: Thinking about your visit to the Lowell Project impoundment...Please rate the crowding:
Count
% of respondents
60
50
40
30
20
10
0
53
20
3
8
1
6.6
1
6.6
2
13.8
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

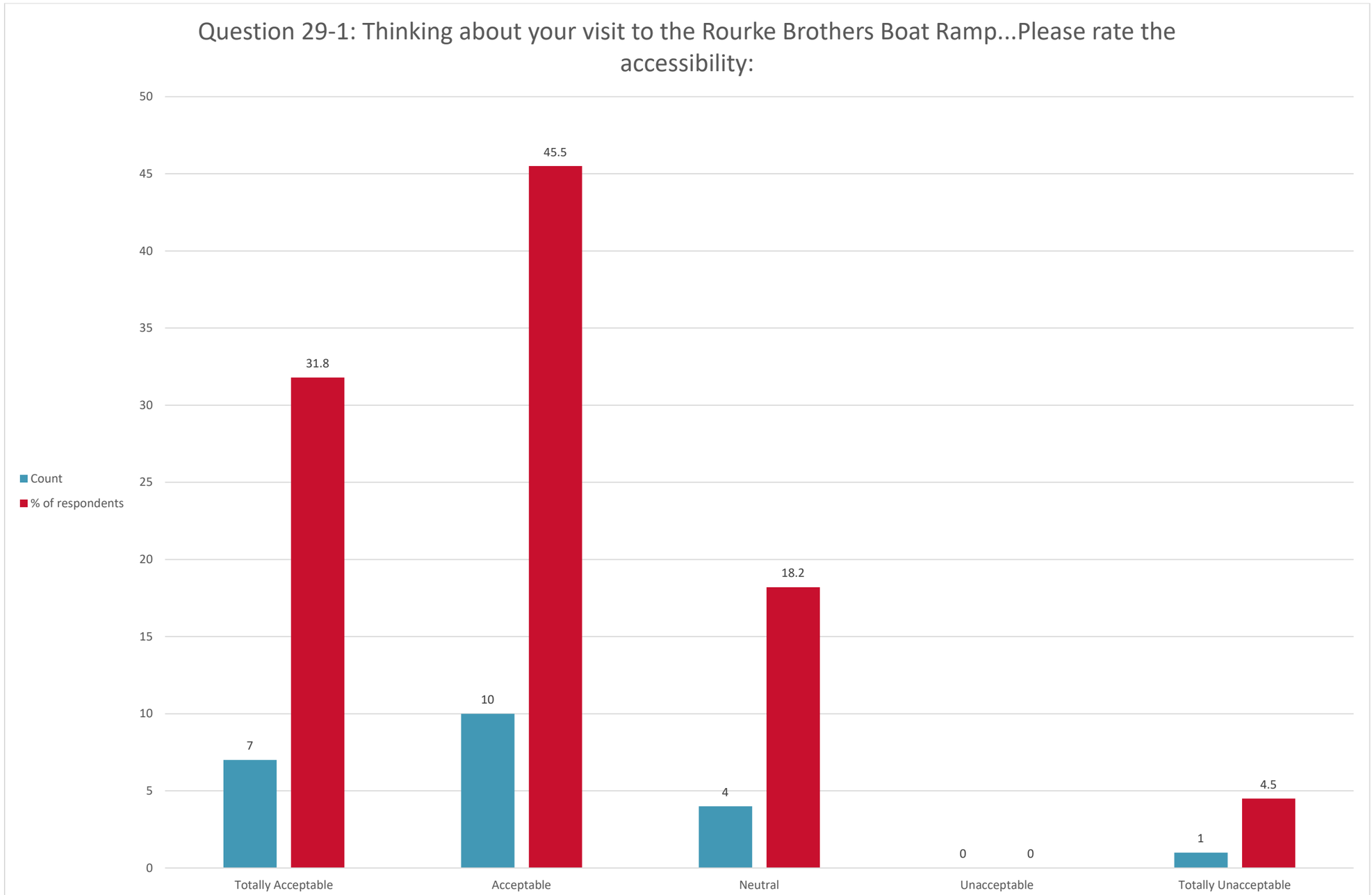

Question 28-4: Thinking about your visit to the Lowell Project impoundment...Please rate the safety:
Count
% of respondents
35
30
25
20
15
10
5
0
33.3
33.3
20
6.7
5
5
6.7
3
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

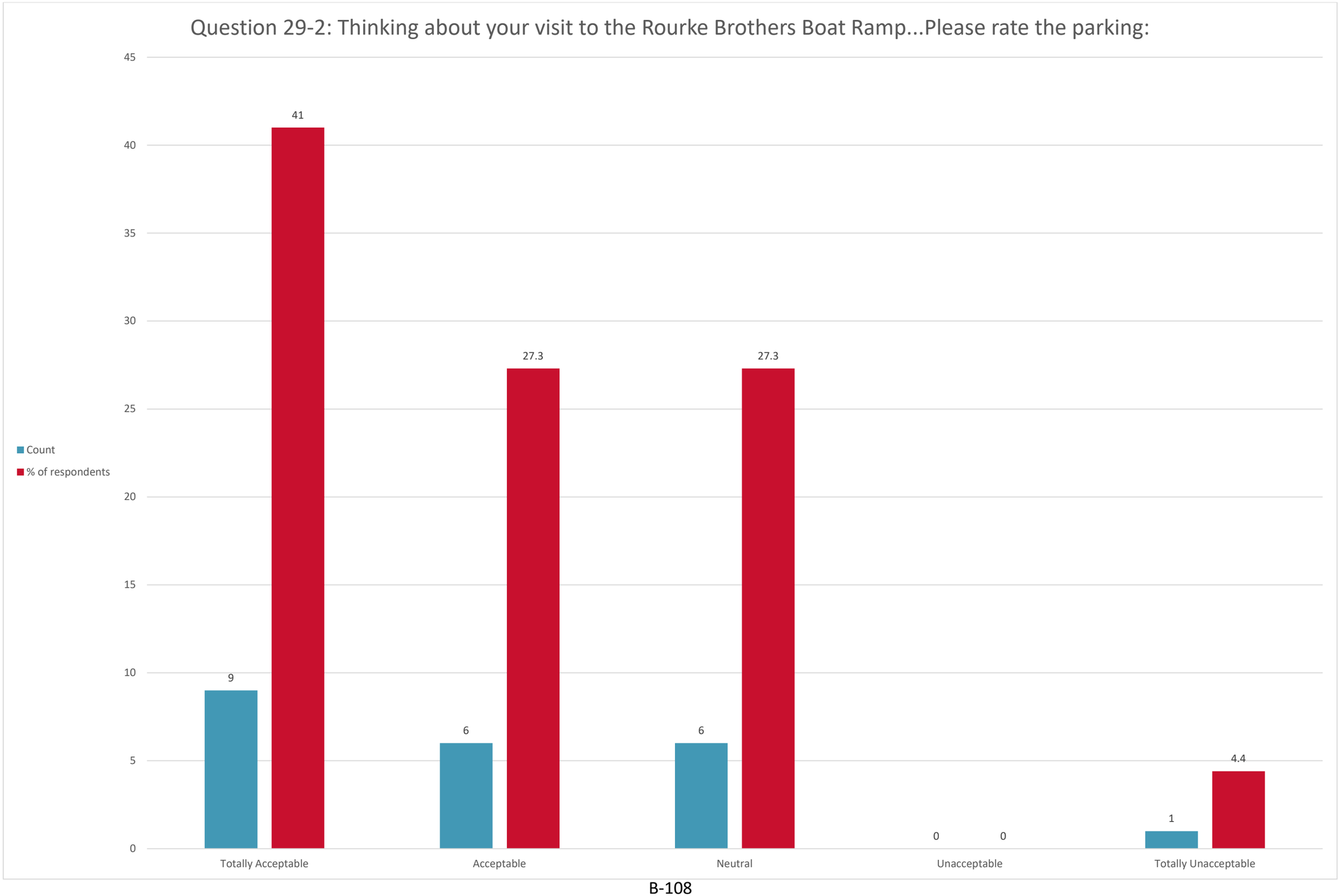

Question 28-5: Thinking about your visit to the Lowell Project impoundment...Please rate the condition of the facilities:
Count
% of respondents
30
25
20
15
10
5
0
2
13.4
3
20
4
26.6
4
26.6
2
13.4
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

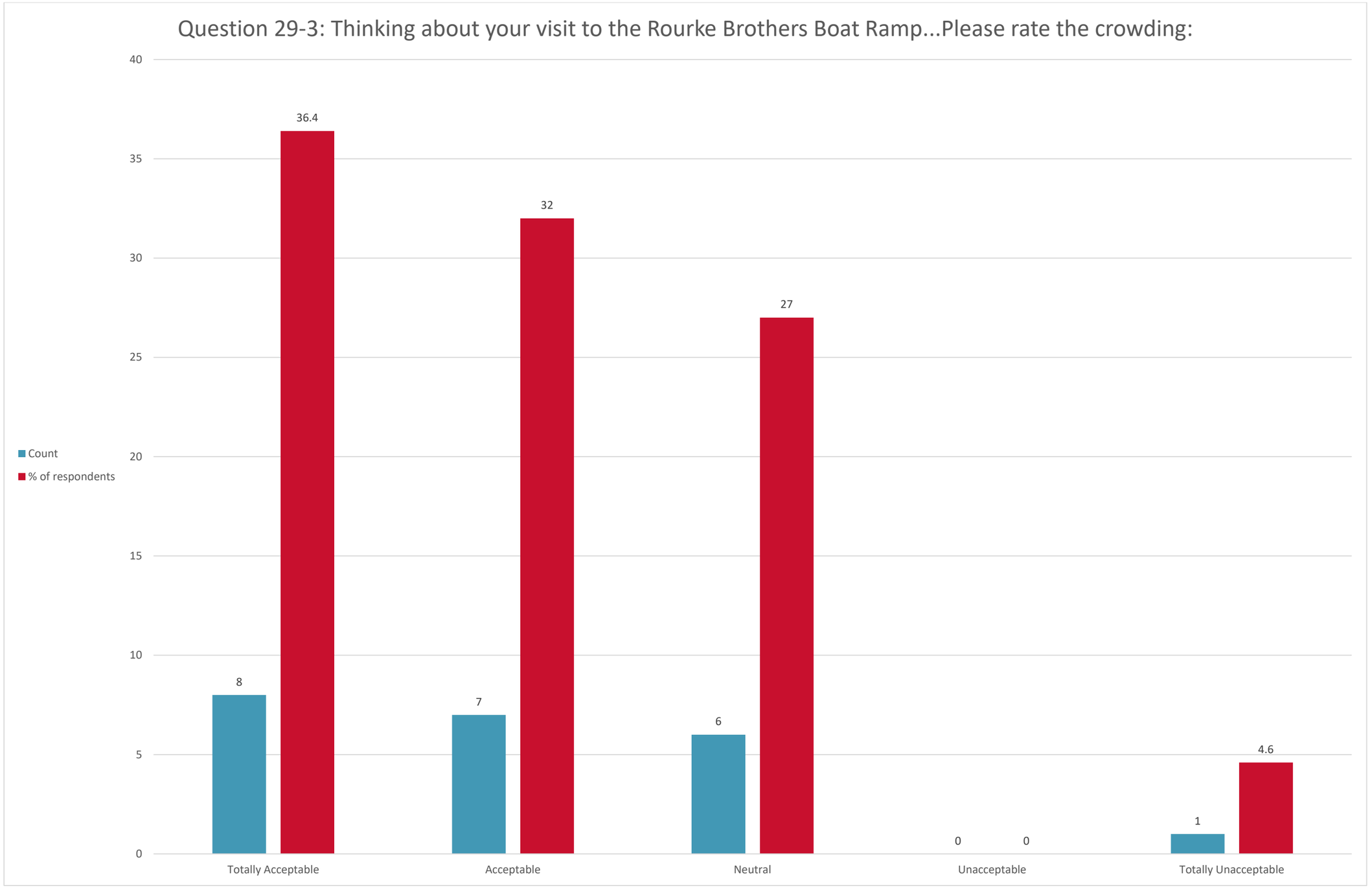

Question 28-6: Thinking about your visit to the Lowell Project impoundment...Please rate the availability of amenities:
Count
% of respondents
30
25
20
15
10
5
0
13.4
20
26.6
26.6
13.4
2
4
3
3
3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

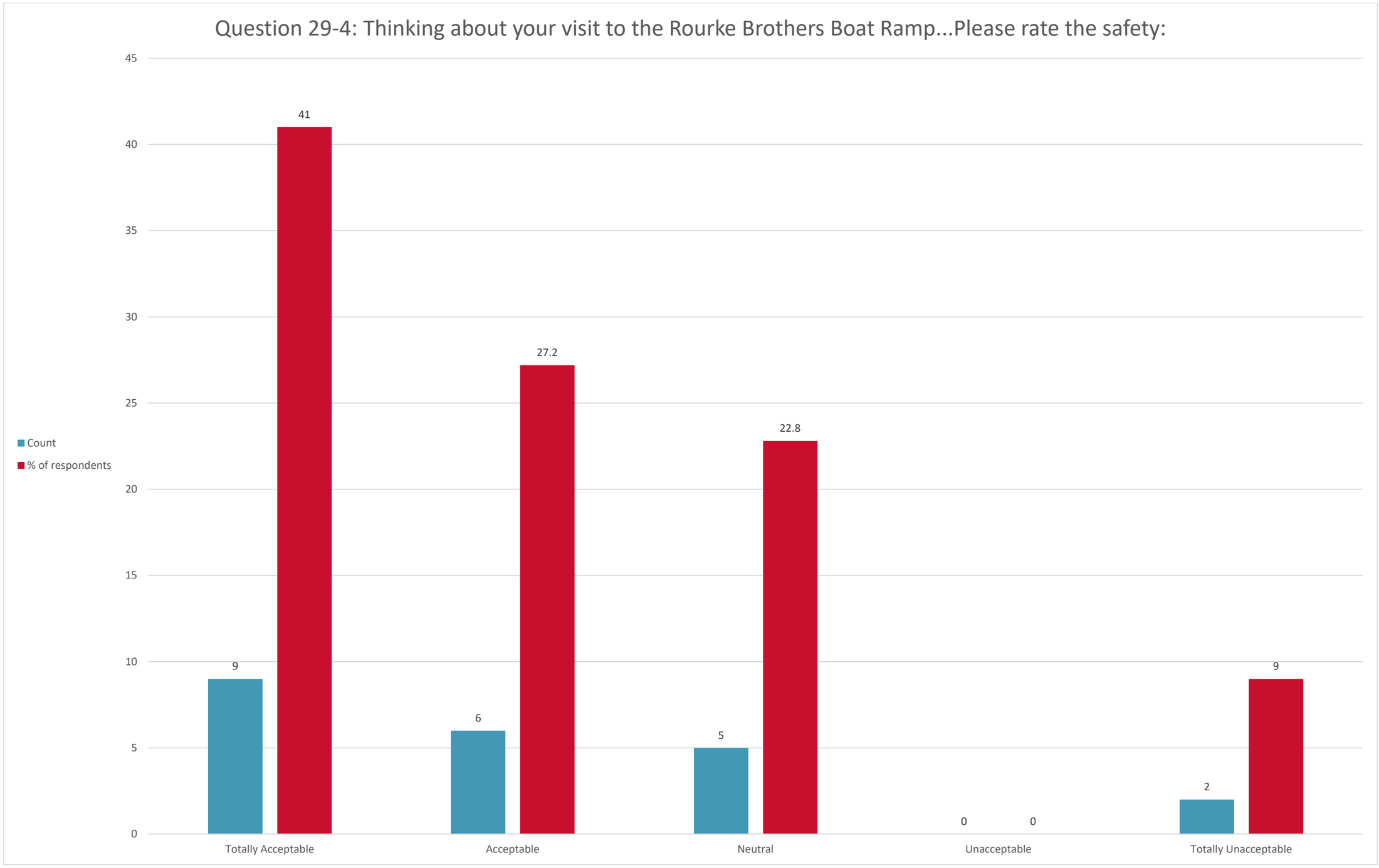

Question 28-7: Thinking about your visit to the Lowell Project impoundment...Please rate the river flow:
Count
% of respondents
40
35
30
25
20
15
10
5
0
33.3
33.3
20
13.4
5
5
2
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

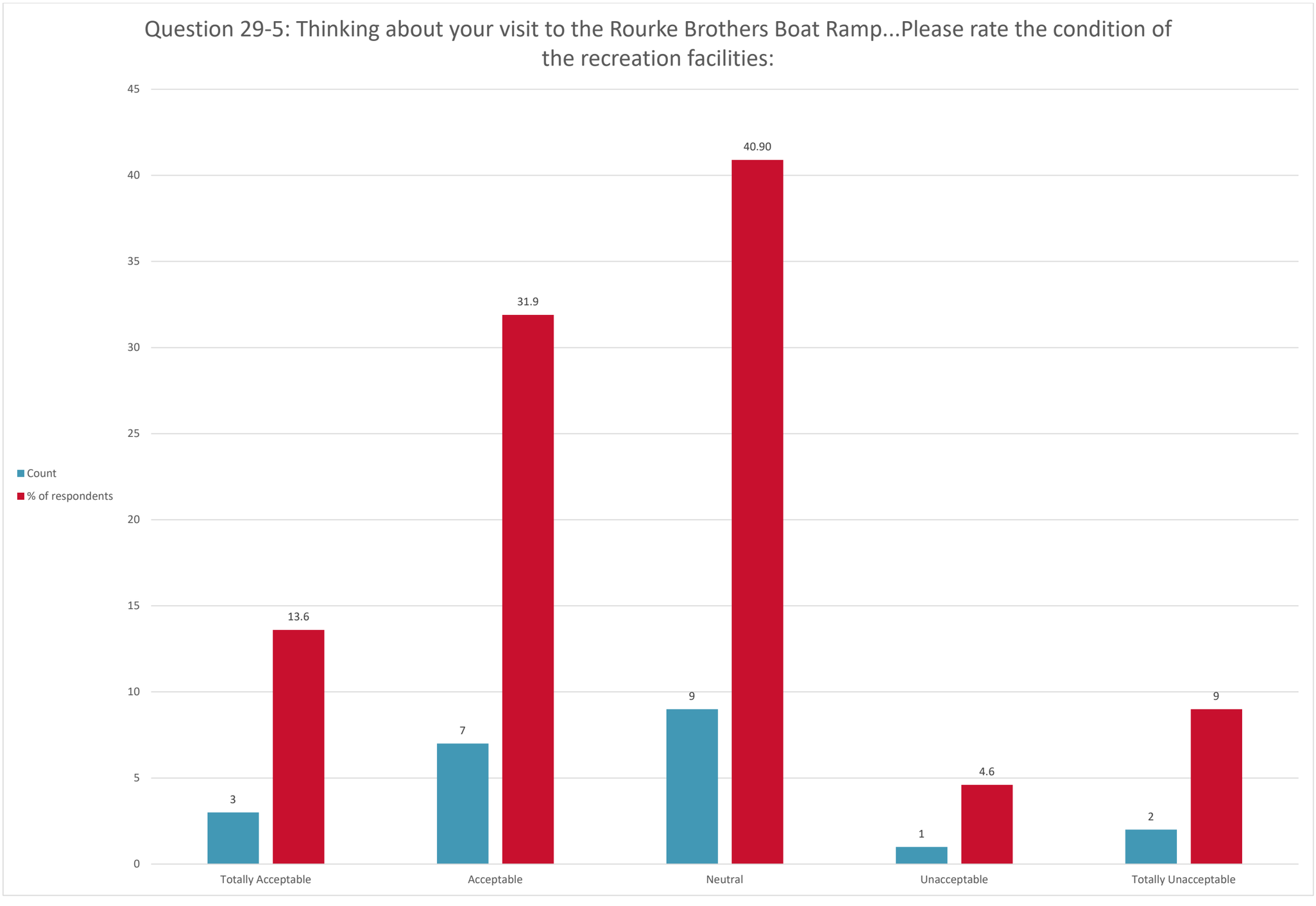

Question 28-8: Thinking about your visit to the Lowell Project impoundment...Please rate your overall experience:
Count
% of respondents
35
30
25
20
15
10
5
0
2
13.4
4
26.7
5
33.3
2
13.3
2
13.3
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

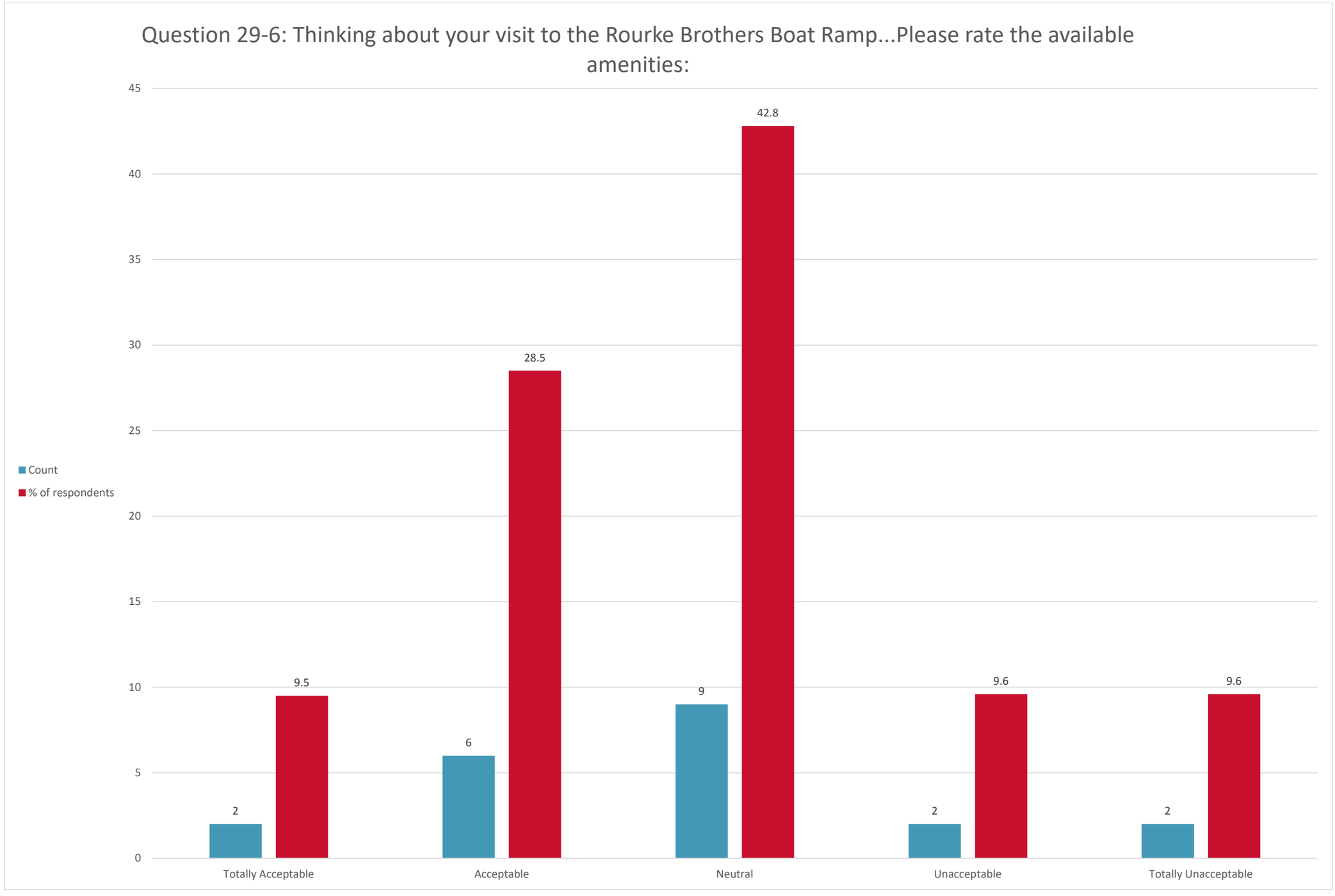

Question 29-1: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the accessibility:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
31.8
45.5
18.2
7
10
4
0
0
1
4.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

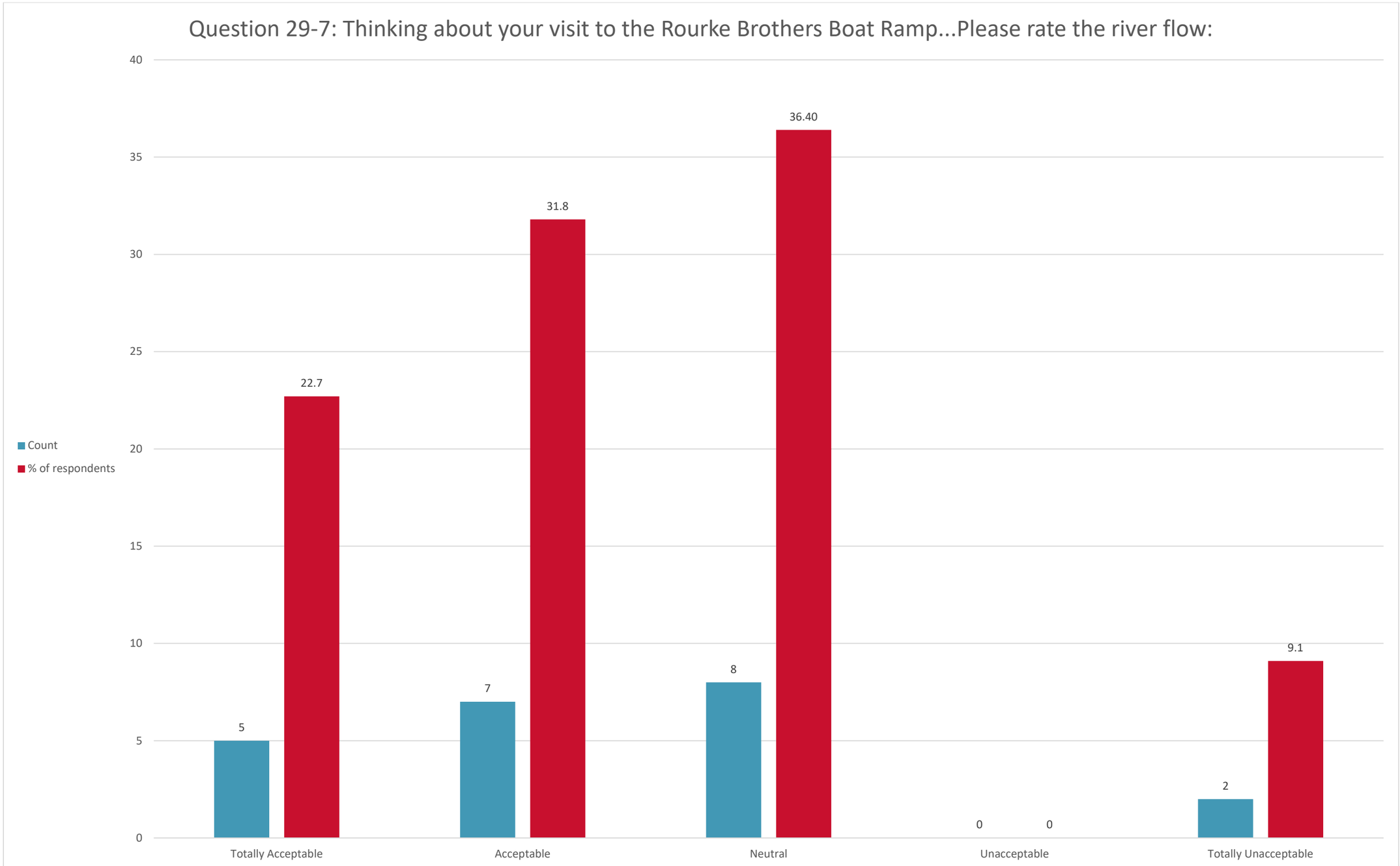

Question 29-2: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the parking:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
41
27.3
27.3
9
6
6
0
0
1
4.4
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

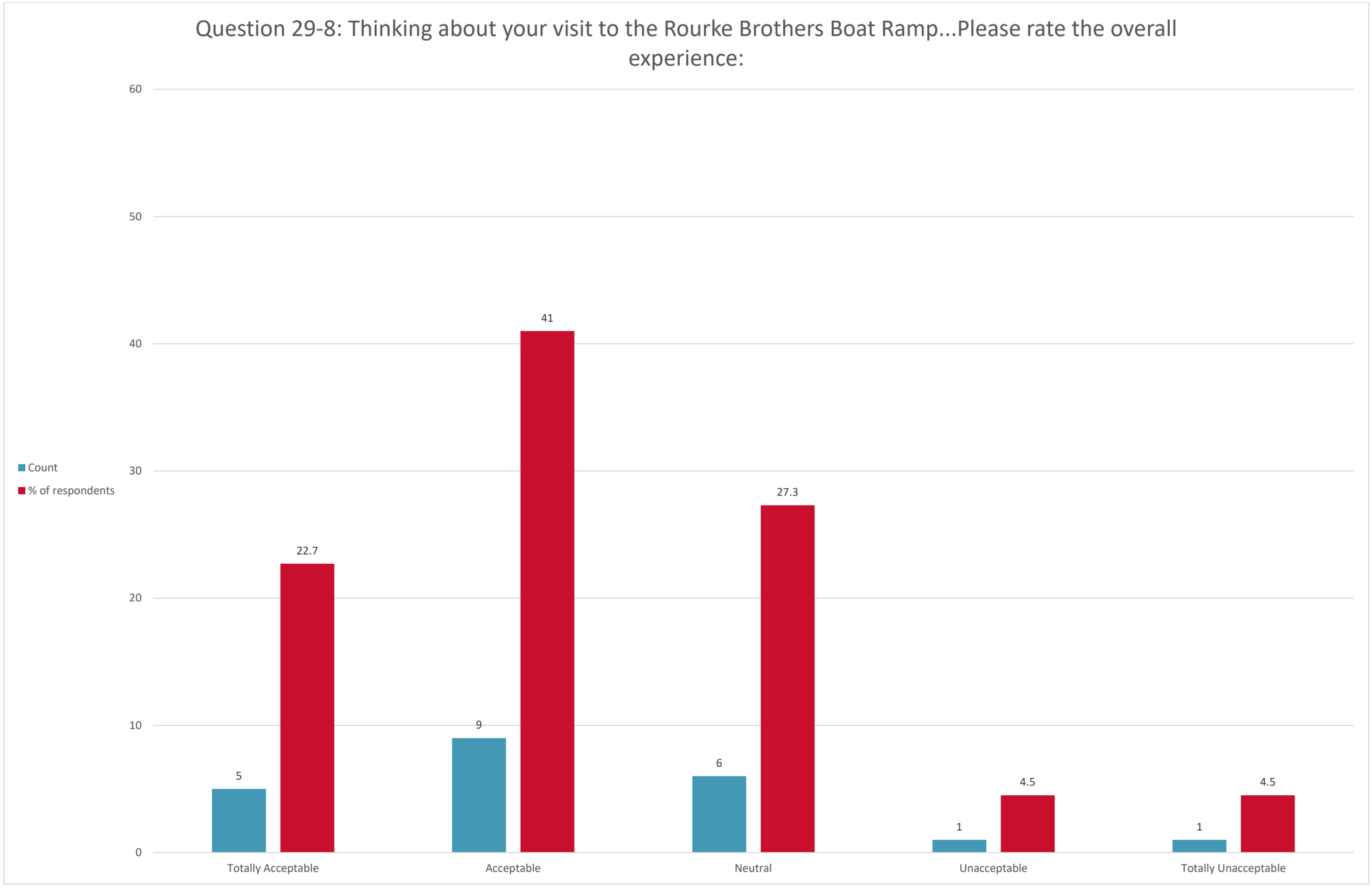

Question 29-3: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the crowding:
Count
% of respondents
40
35
30
25
20
15
10
5
0
36.4
32
27
8
7
6
0
0
1
4.6
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

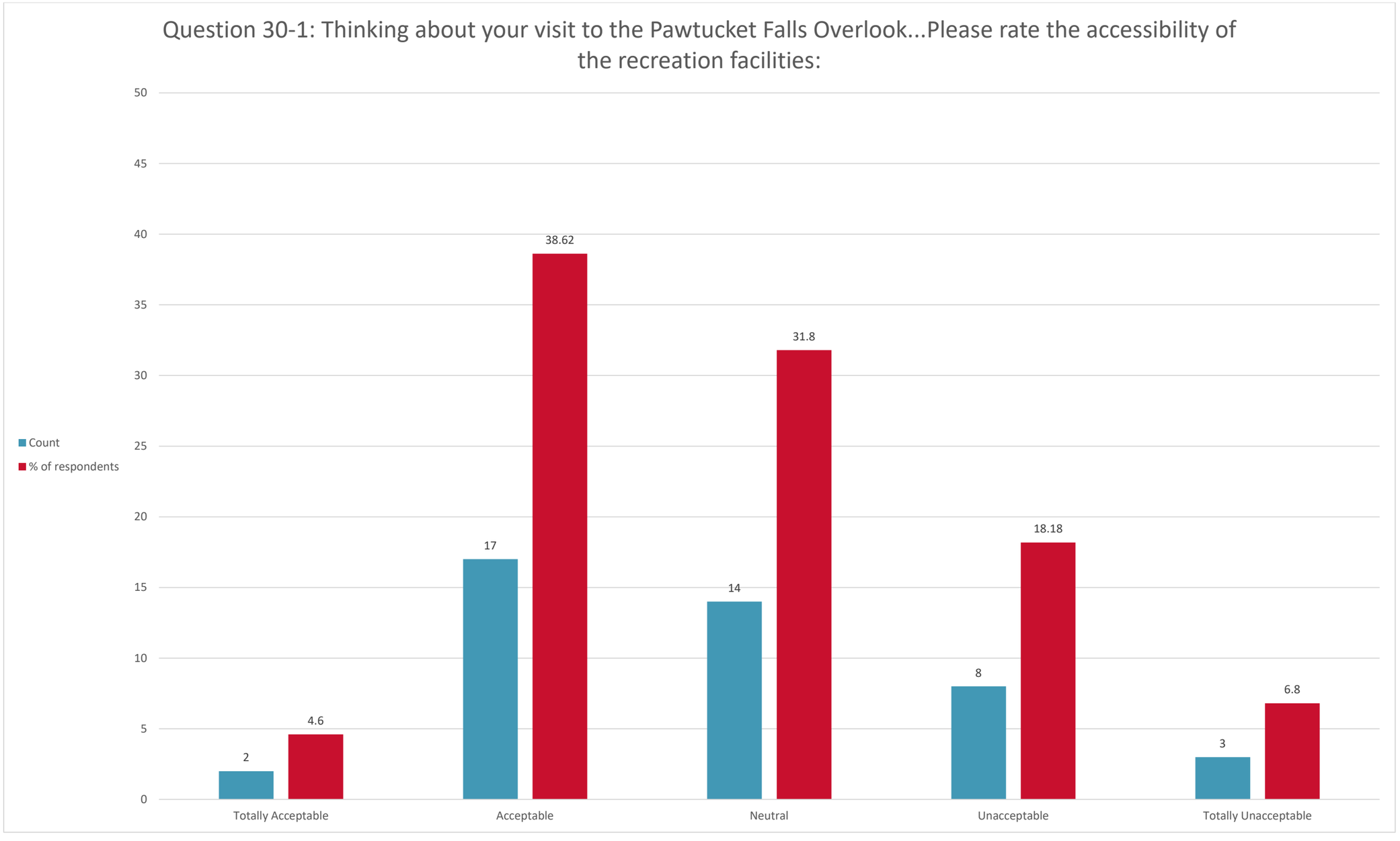

Question 29-4: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the safety:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
41
27.2
22.8
9
6
5
0
0
2
9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

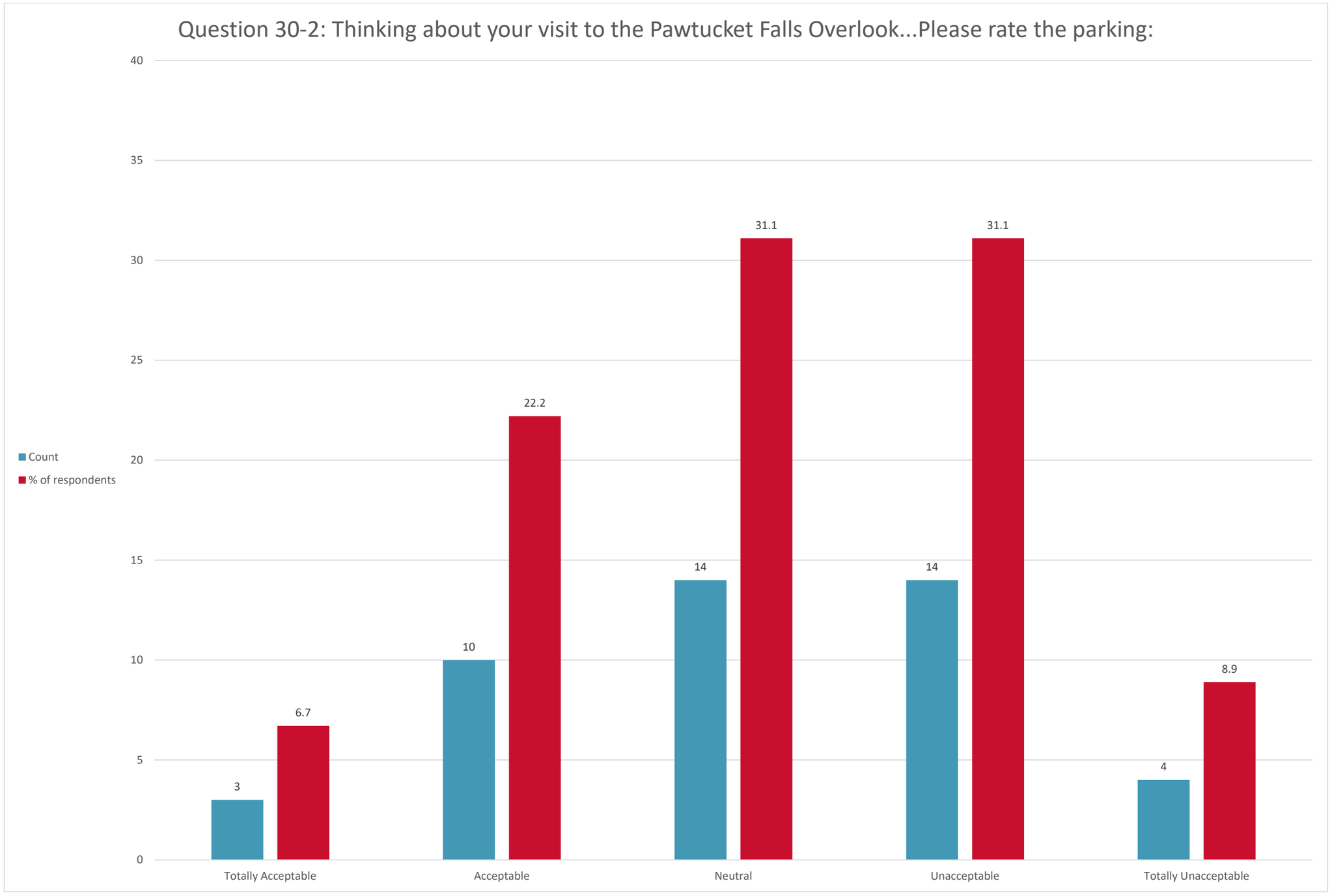

Question 29-5: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the condition of the recreation facilities:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
3
13.6
7
31.9
9
40.90
1
4.6
2
9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

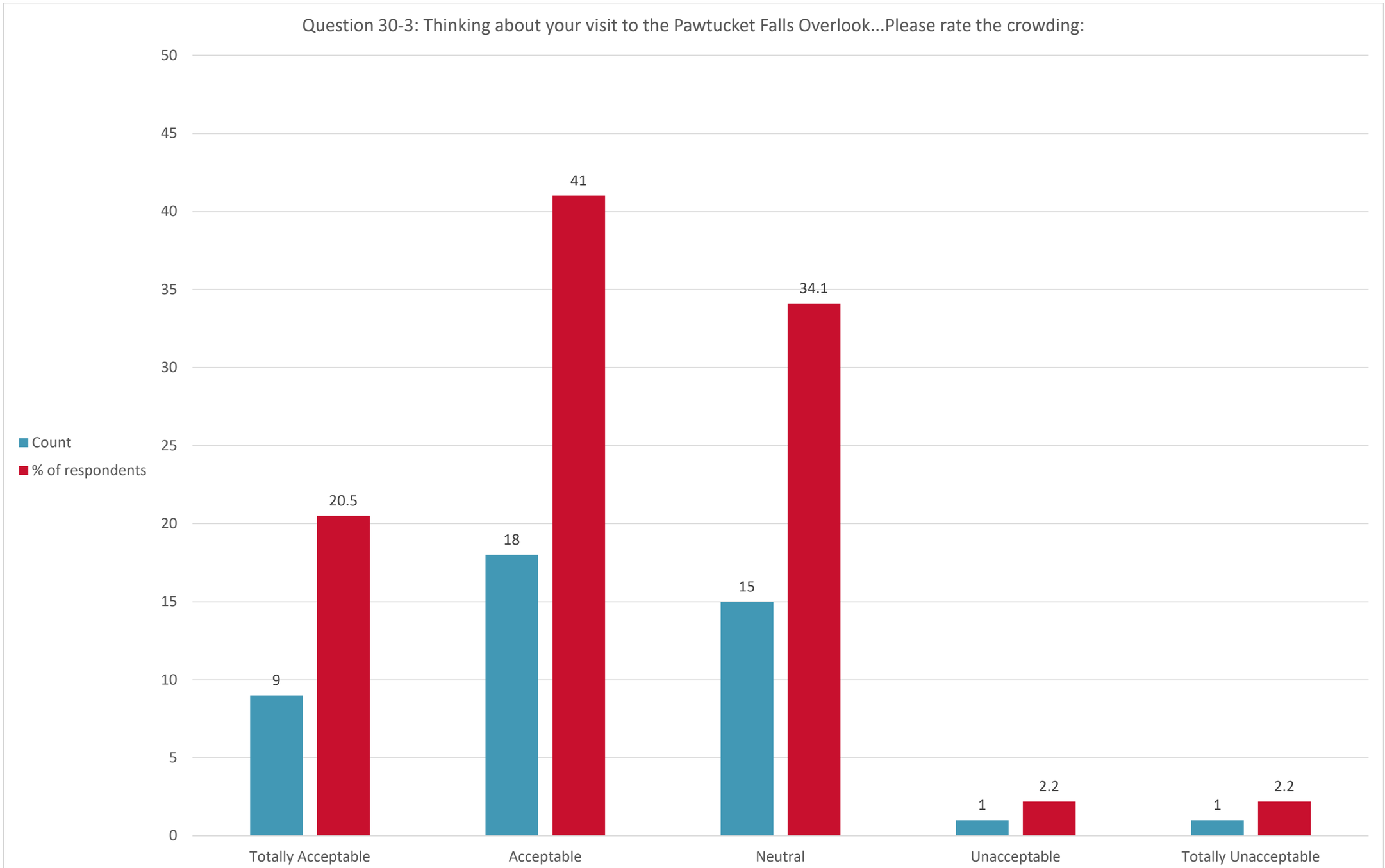

Question 29-6: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the available amenities:
45
40
35
30
25
20
15
10
5
0
Count
% of respondents
28.5
42.8
9.5
6
9
9.6
9.6
2
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

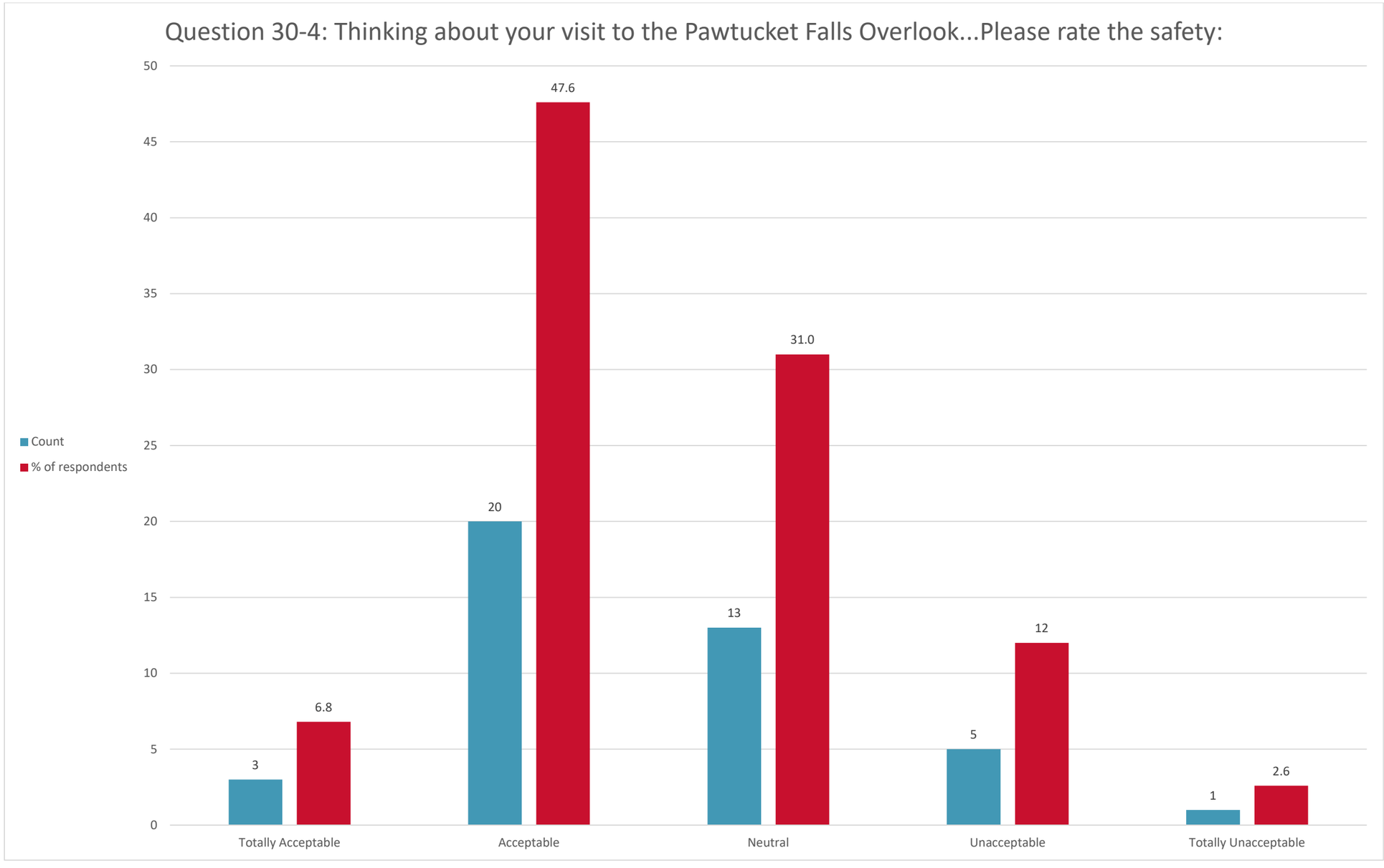

Question 29-7: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the river flow:
Count
% of respondents
40
35
30
25
20
15
10
5
0
22.7
31.8
36.40
5
7
8
0
0
2
9.1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

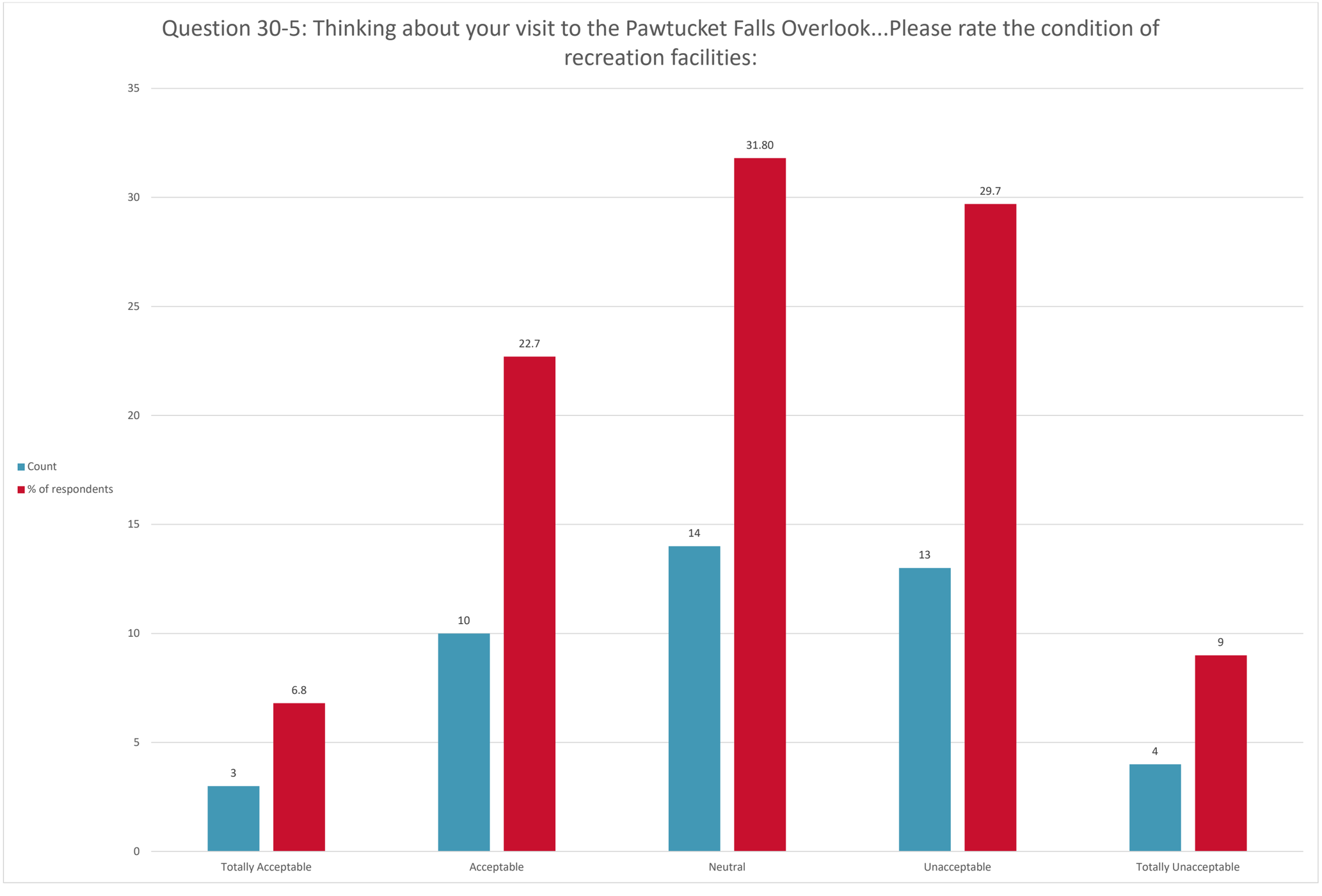

Question 29-8: Thinking about your visit to the Rourke Brothers Boat Ramp...Please rate the overall experience:
60
50
40
30
20
10
0
Count
% of respondents
5
22.7
9
41
6
27.3
1
4.5
1
4.5
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

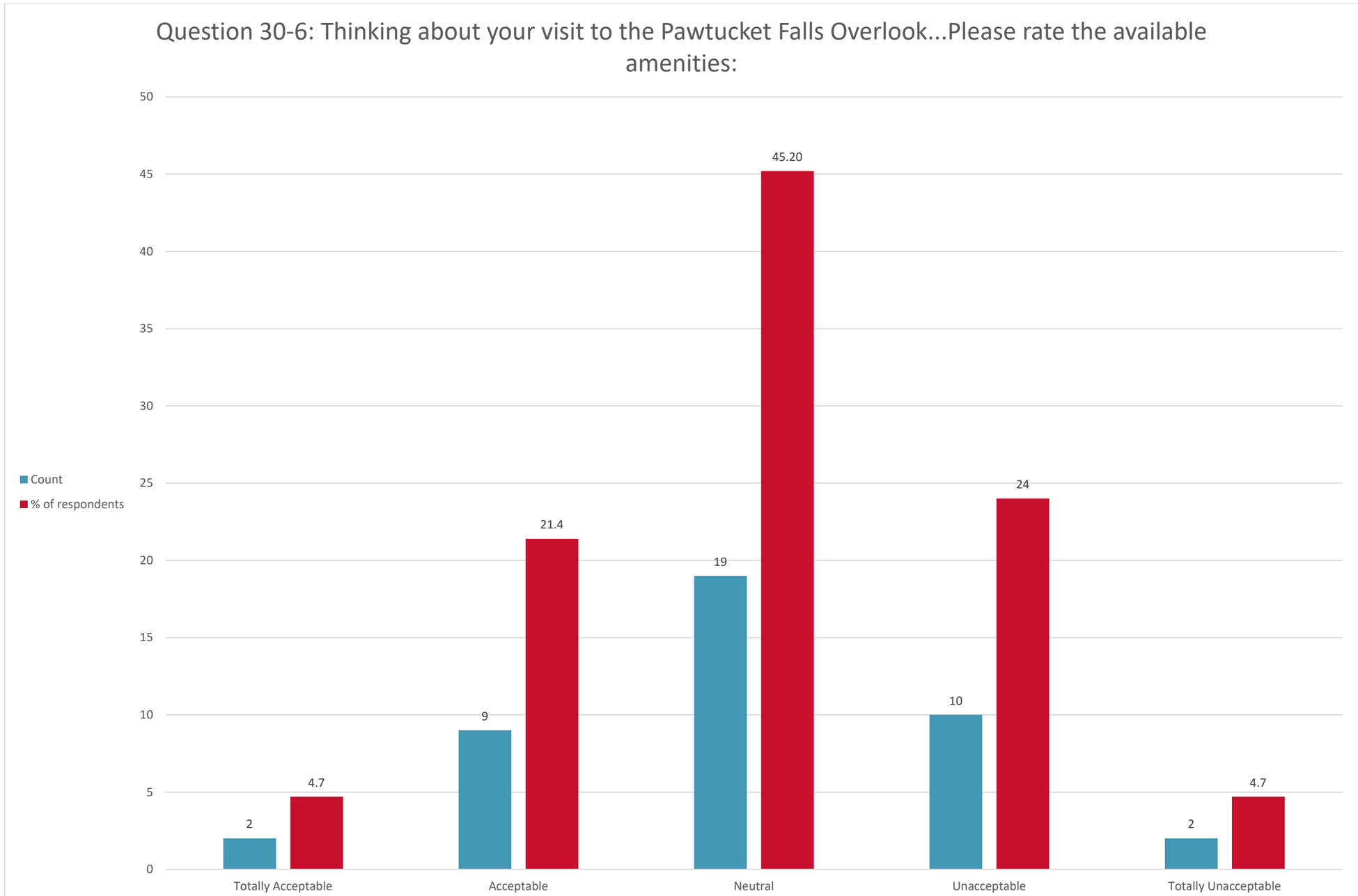

Question 30-1: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the accessibility of the recreation facilities:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
38.62
31.8
18.18
17
14
8
6.8
4.6
3
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

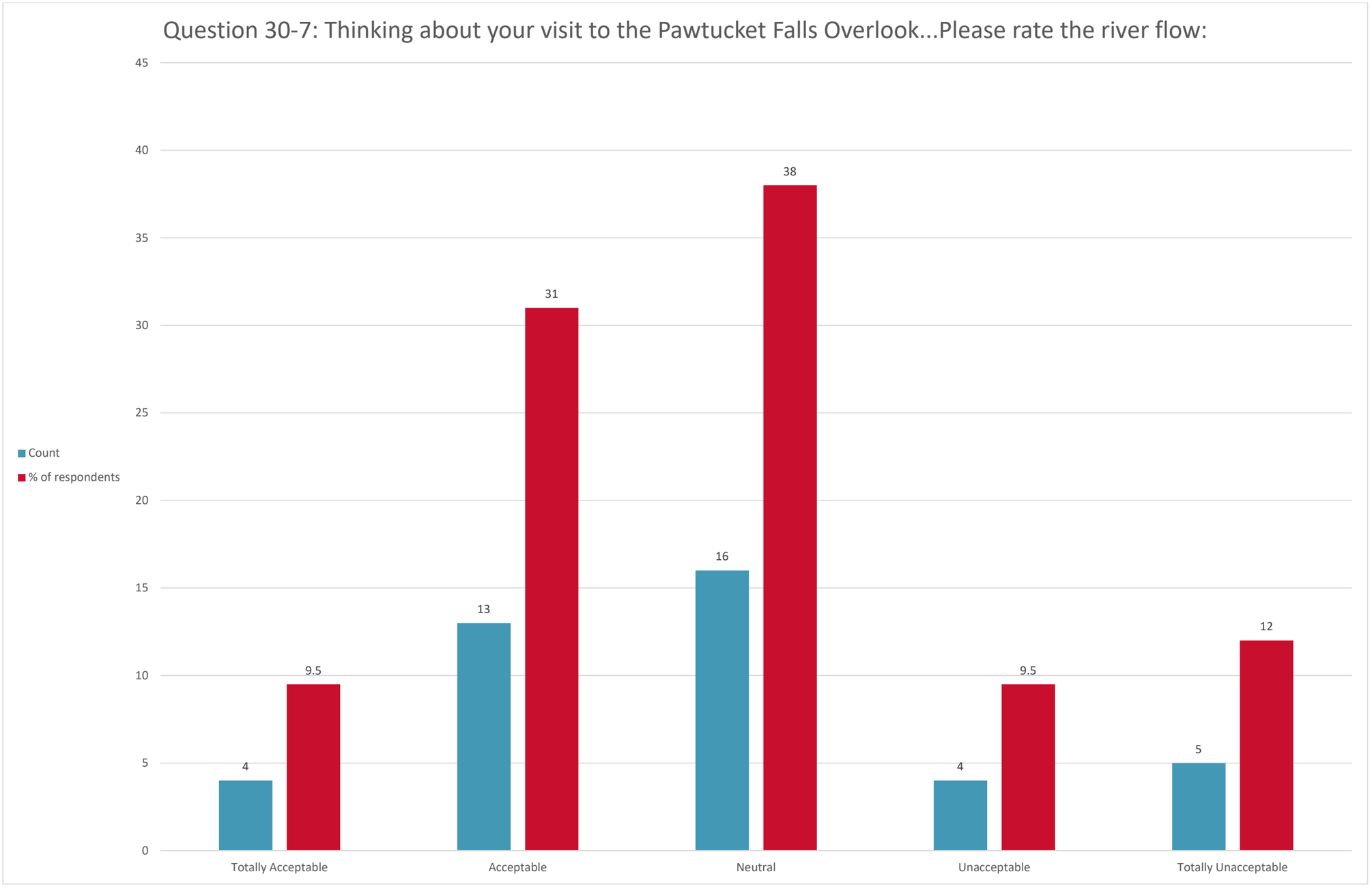

Question 30-2: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the parking:
Count
% of respondents
40
35
30
25
20
15
10
5
0
3
6.7
10
22.2
14
31.1
14
31.1
4
8.9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

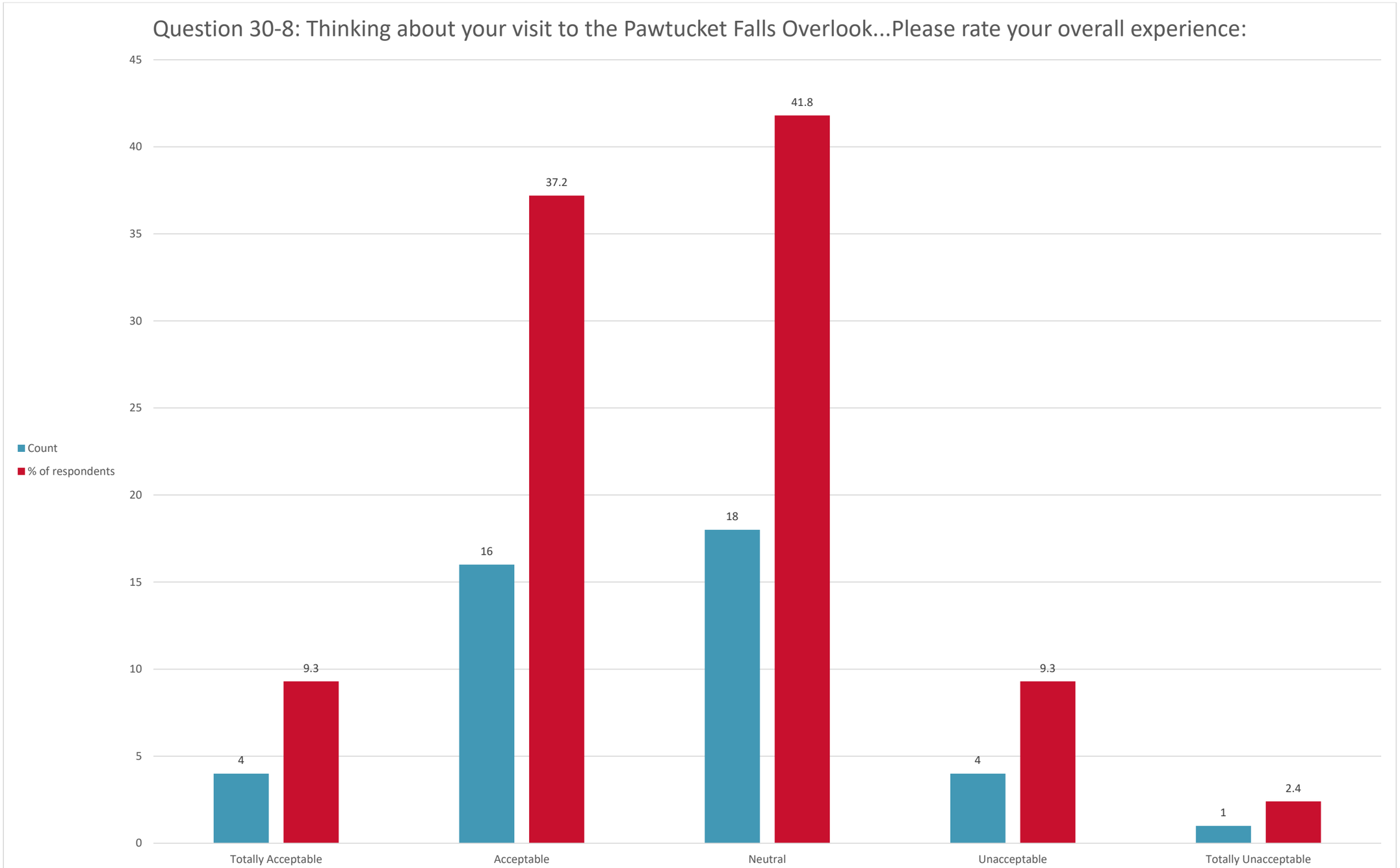

Question 30-3: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the crowding:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
9
20.5
18
41
15
34.1
1
2.2
1
2.2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

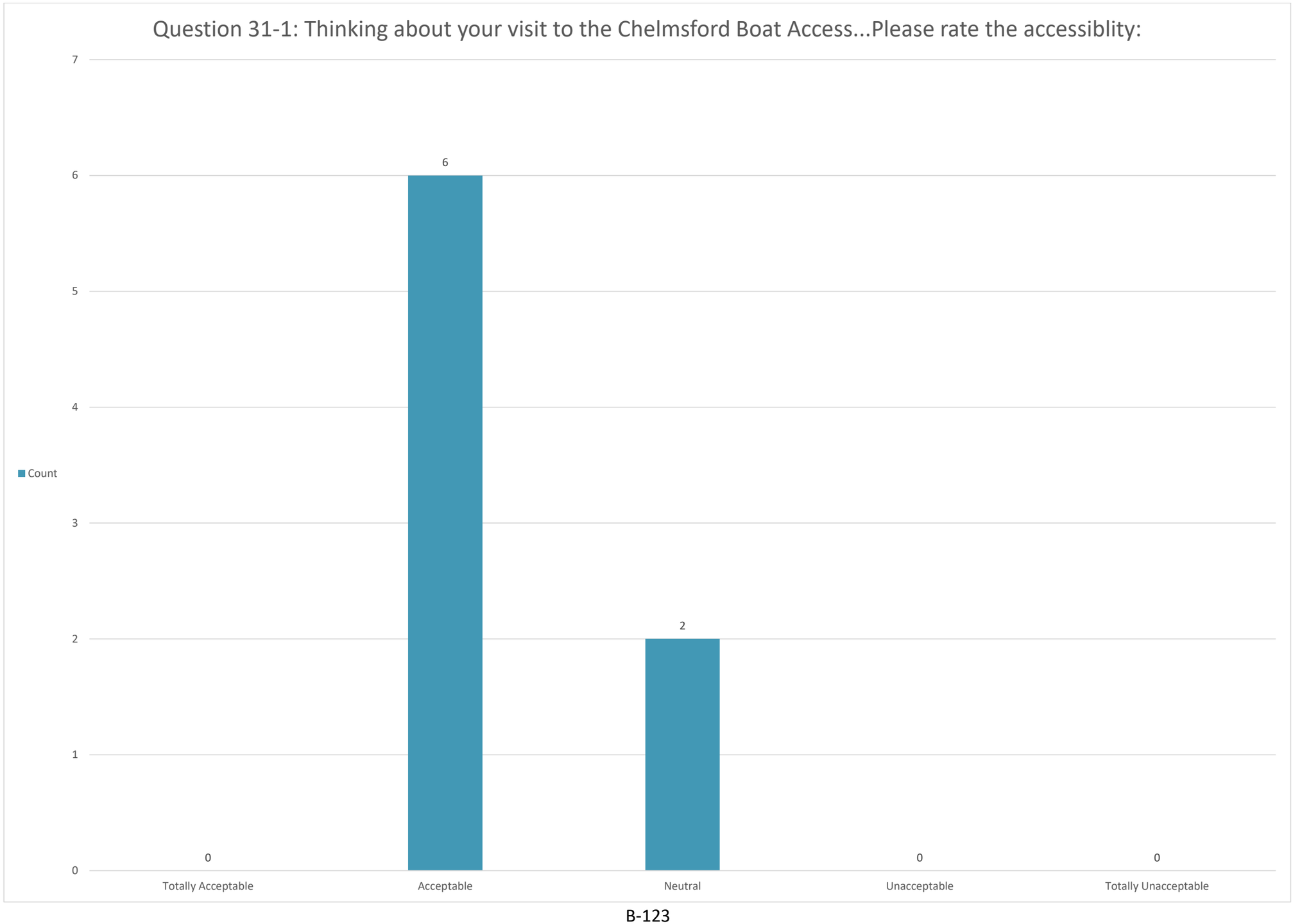

Question 30-4: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the safety:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
3
6.8
20
47.6
13
31.0
5
12
1
2.6
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

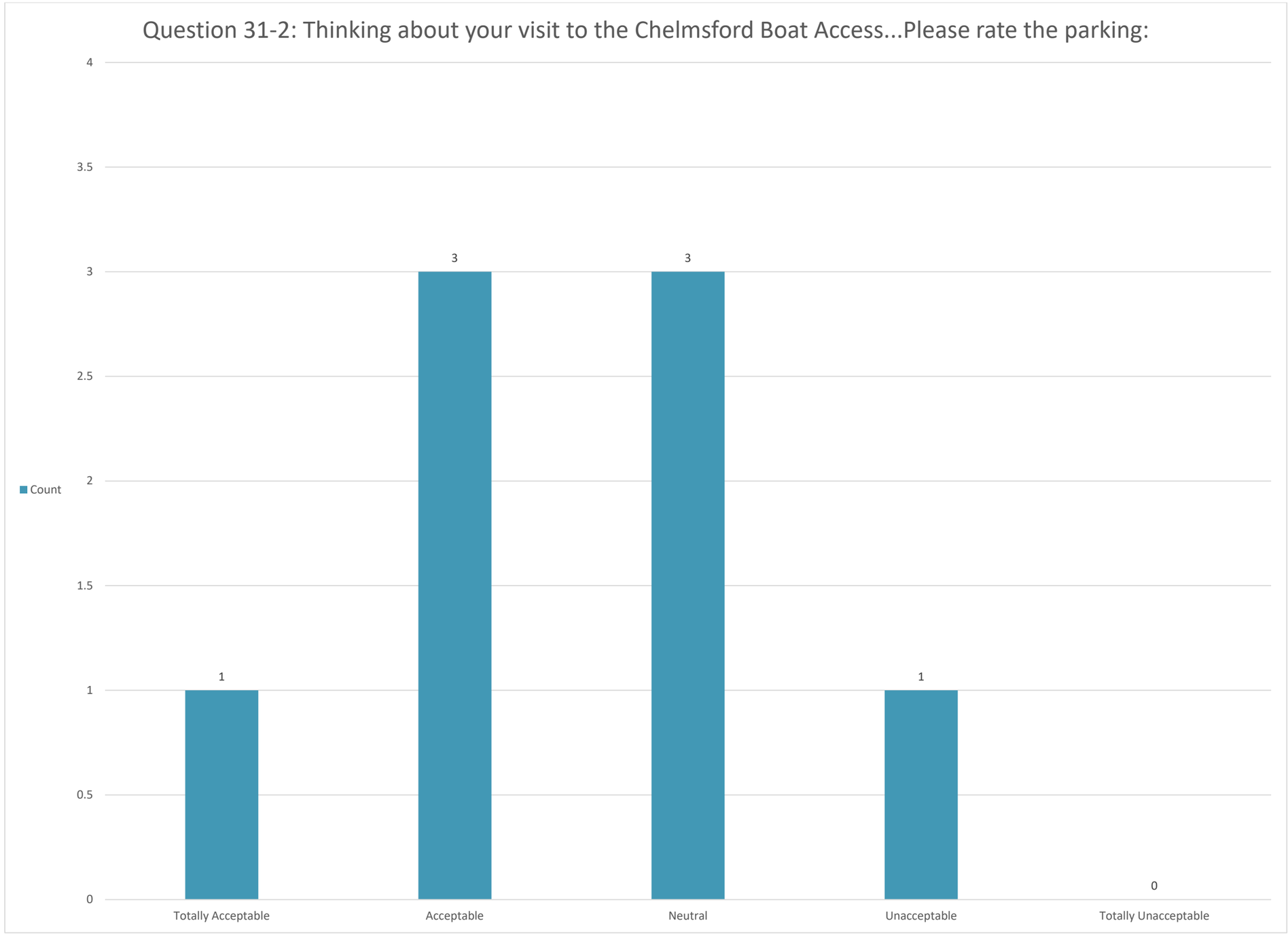

Question 30-5: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the condition of recreation facilities:
35
30
25
20
15
10
5
0
Count
% of respondents
3
6.8
10
22.7
14
31.80
13
29.7
4
9
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

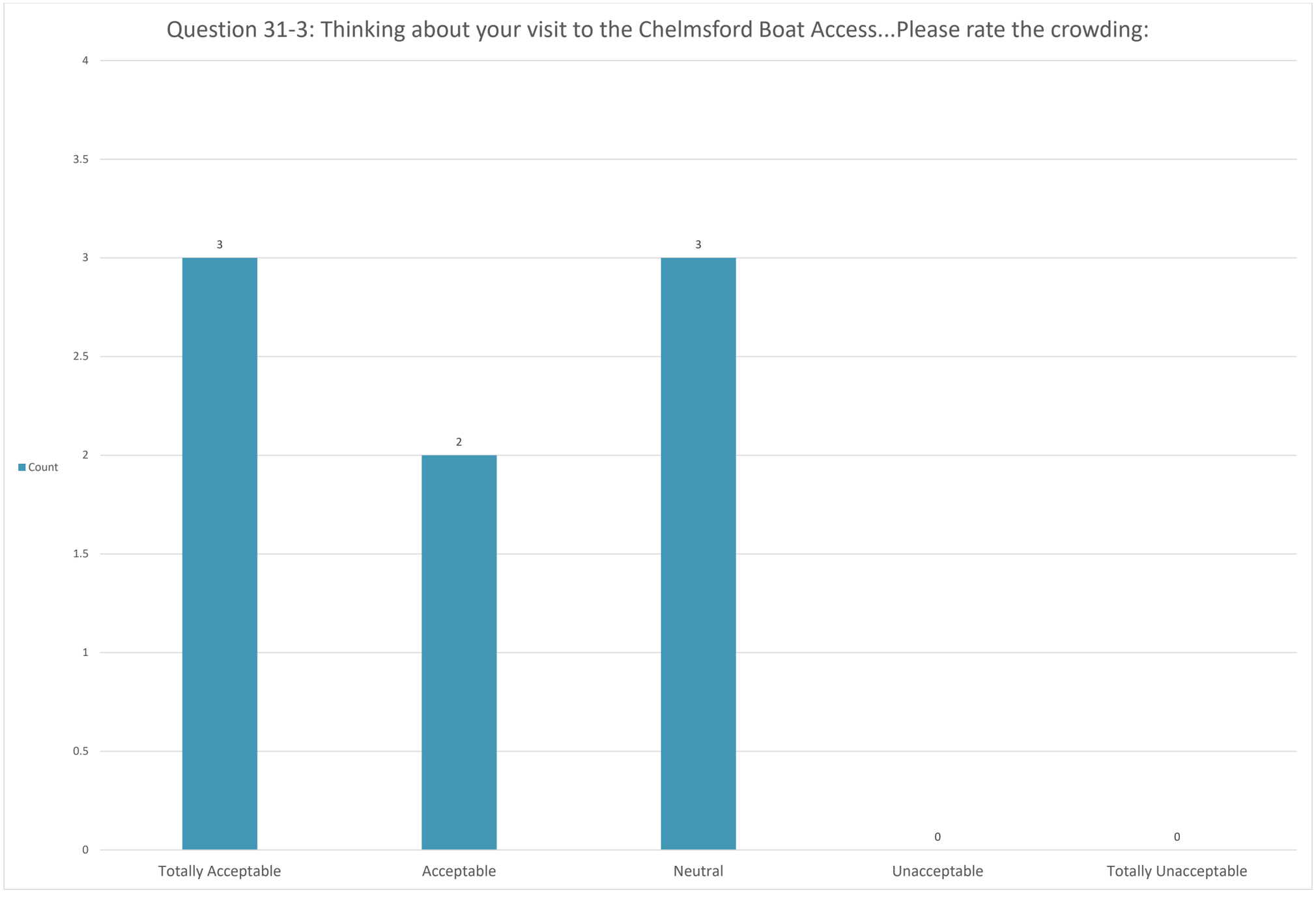

Question 30-6: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the available amenities:
Count
% of respondents
50
45
40
35
30
25
20
15
10
5
0
2
4.7
9
21.4
19
45.20
10
24
2
4.7
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

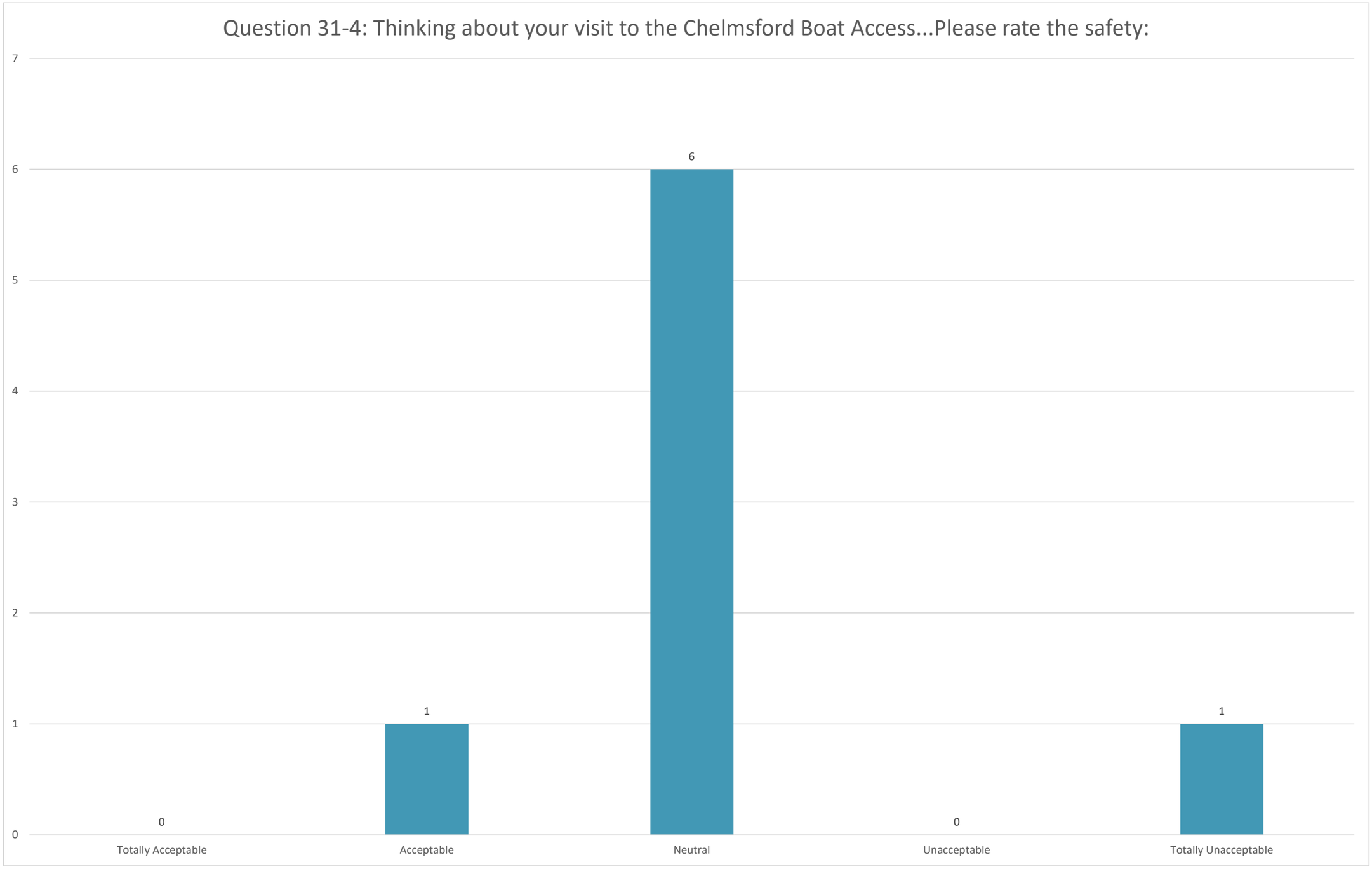

Question 30-7: Thinking about your visit to the Pawtucket Falls Overlook...Please rate the river flow:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
4
9.5
13
31
16
38
4
9.5
5
12
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

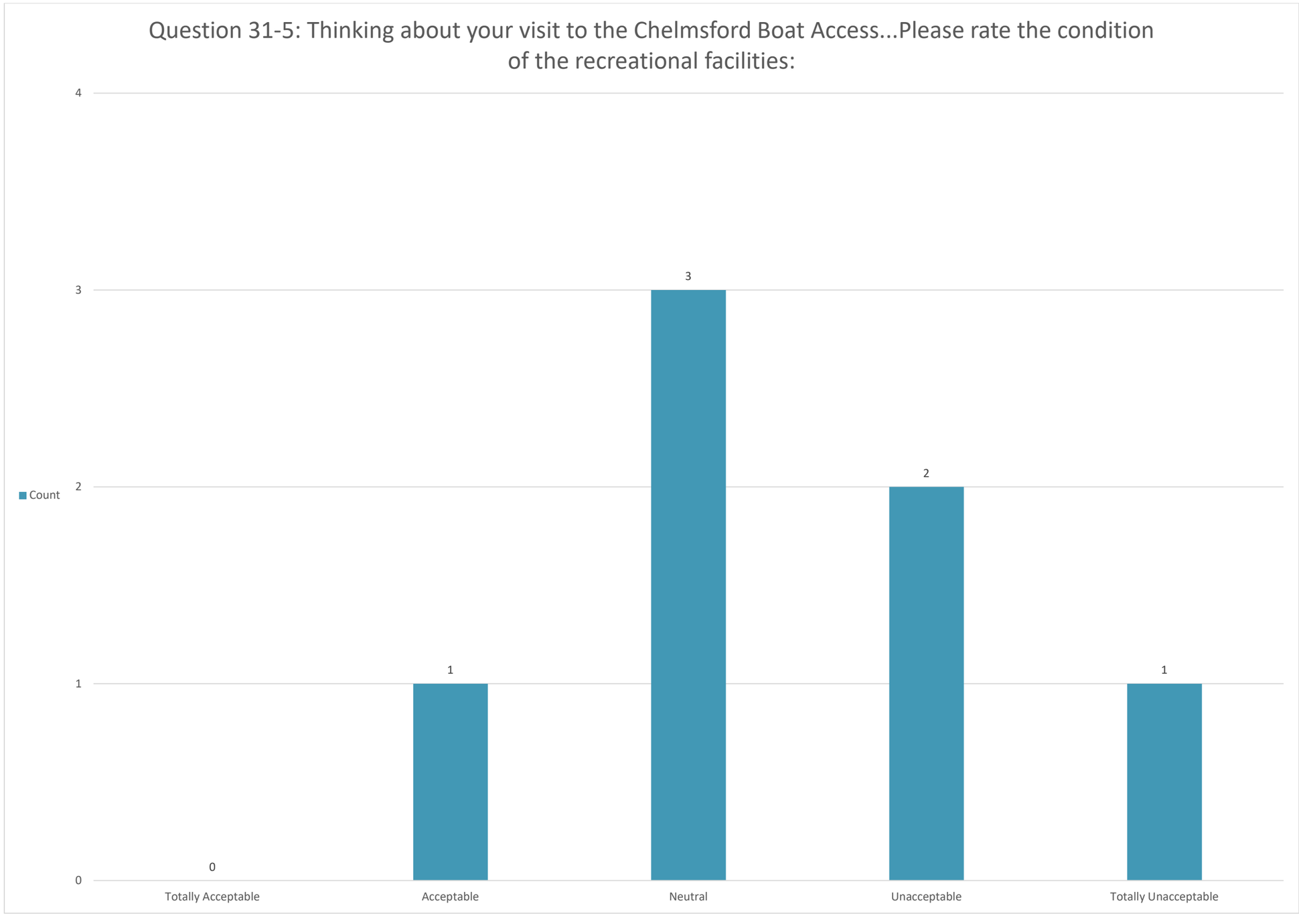

Question 30-8: Thinking about your visit to the Pawtucket Falls Overlook...Please rate your overall experience:
Count
% of respondents
45
40
35
30
25
20
15
10
5
0
4
9.3
16
37.2
18
41.8
4
9.3
1
2.4
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 31-1: Thinking about your visit to the Chelmsford Boat Access...Please rate the accessiblity:
7
6
5
4
3
2
1
0
Count
6
2
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

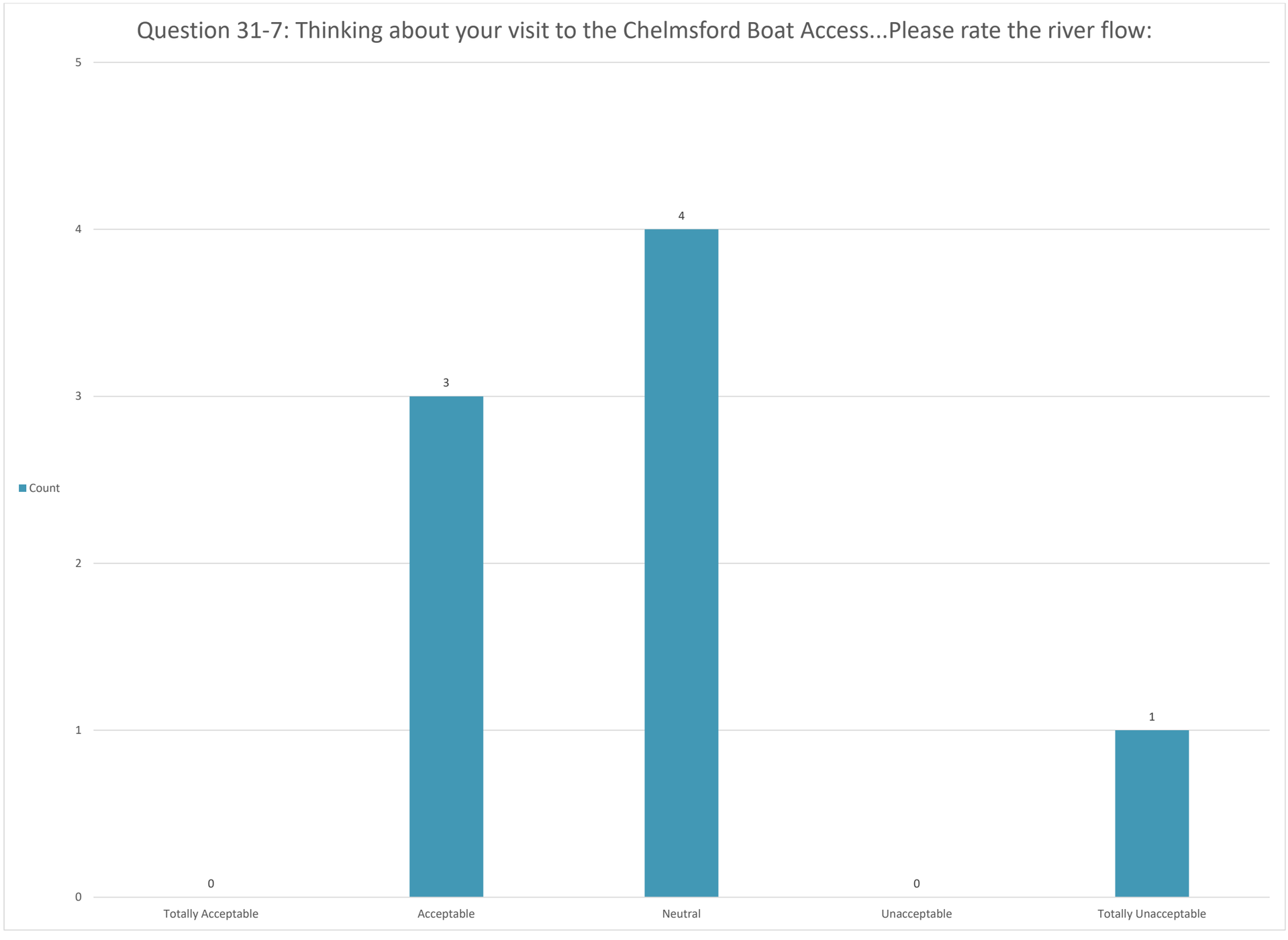

Question 31-2: Thinking about your visit to the Chelmsford Boat Access...Please rate the parking:
Count
4
3.5
3
2.5
2
1.5
1
0.5
0
3
3
1
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

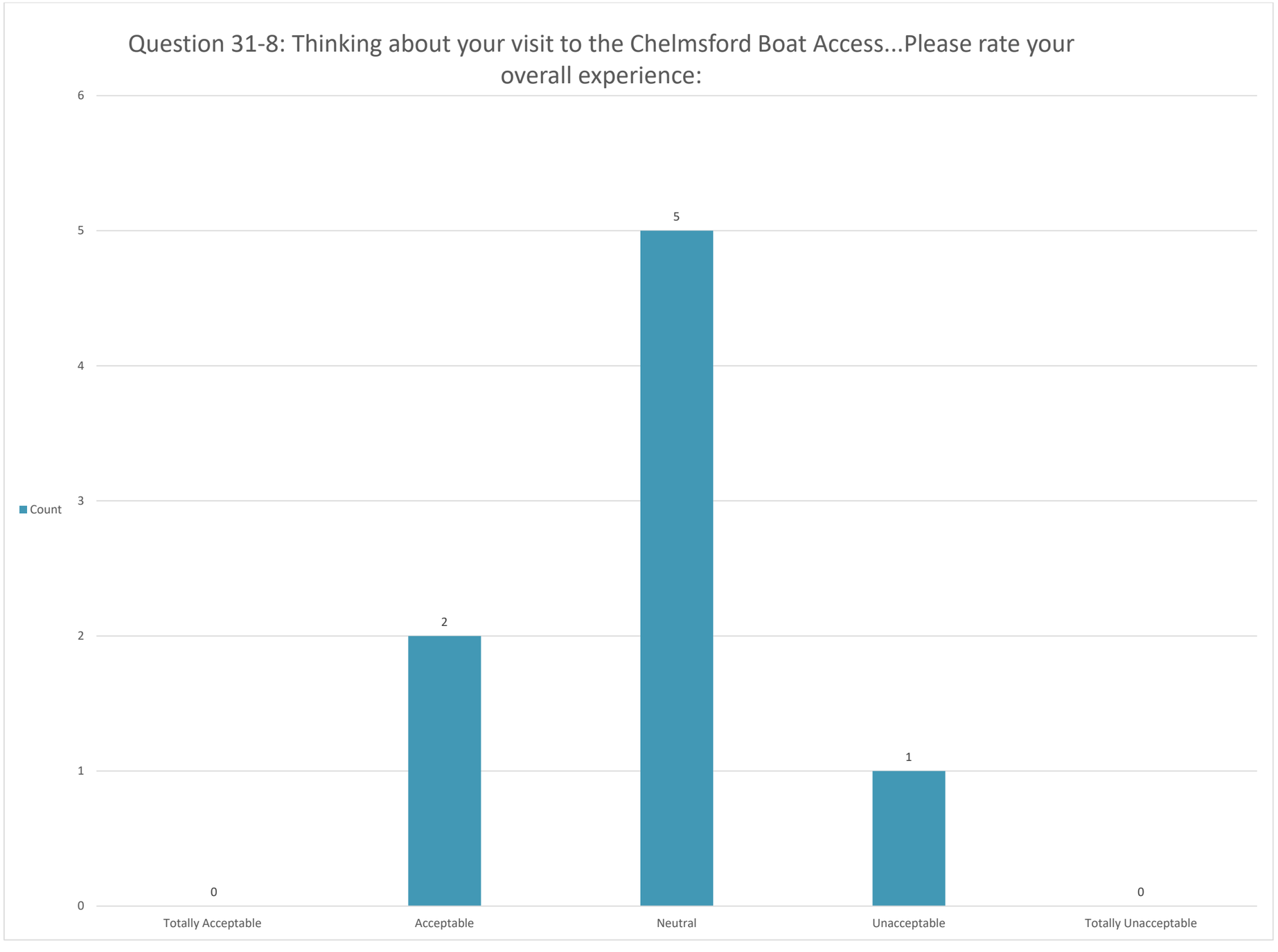

Question 31-3: Thinking about your visit to the Chelmsford Boat Access...Please rate the crowding:
Count
4
3.5
3
2.5
2
1.5
1
0.5
0
3
2
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

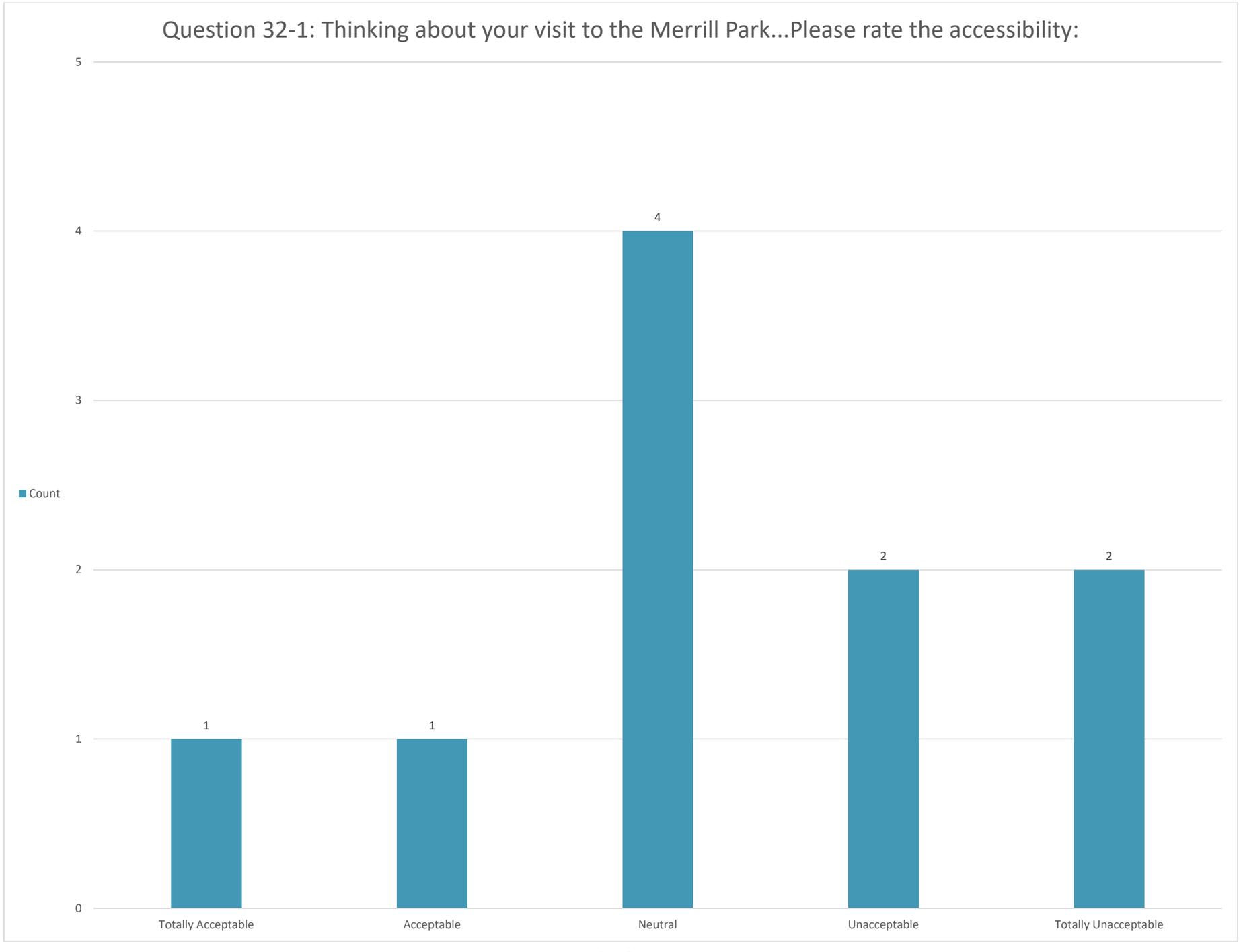

Question 31-4: Thinking about your visit to the Chelmsford Boat Access...Please rate the safety:
7
6
5
4
3
2
1
0
0
1
6
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

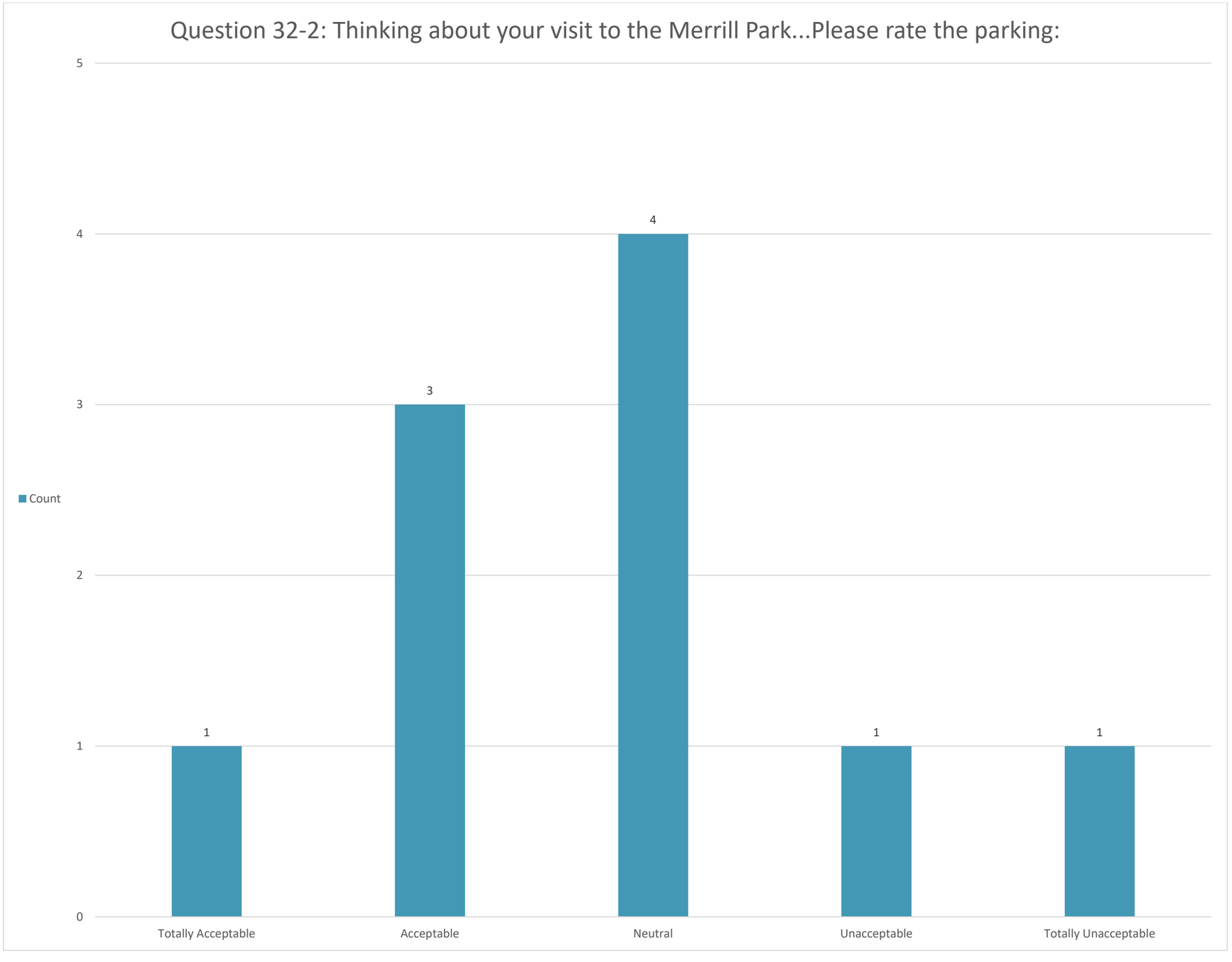

Question 31-5: Thinking about your visit to the Chelmsford Boat Access...Please rate the condition of the recreational facilities:
Count
4
3
2
1
0
0
1
3
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

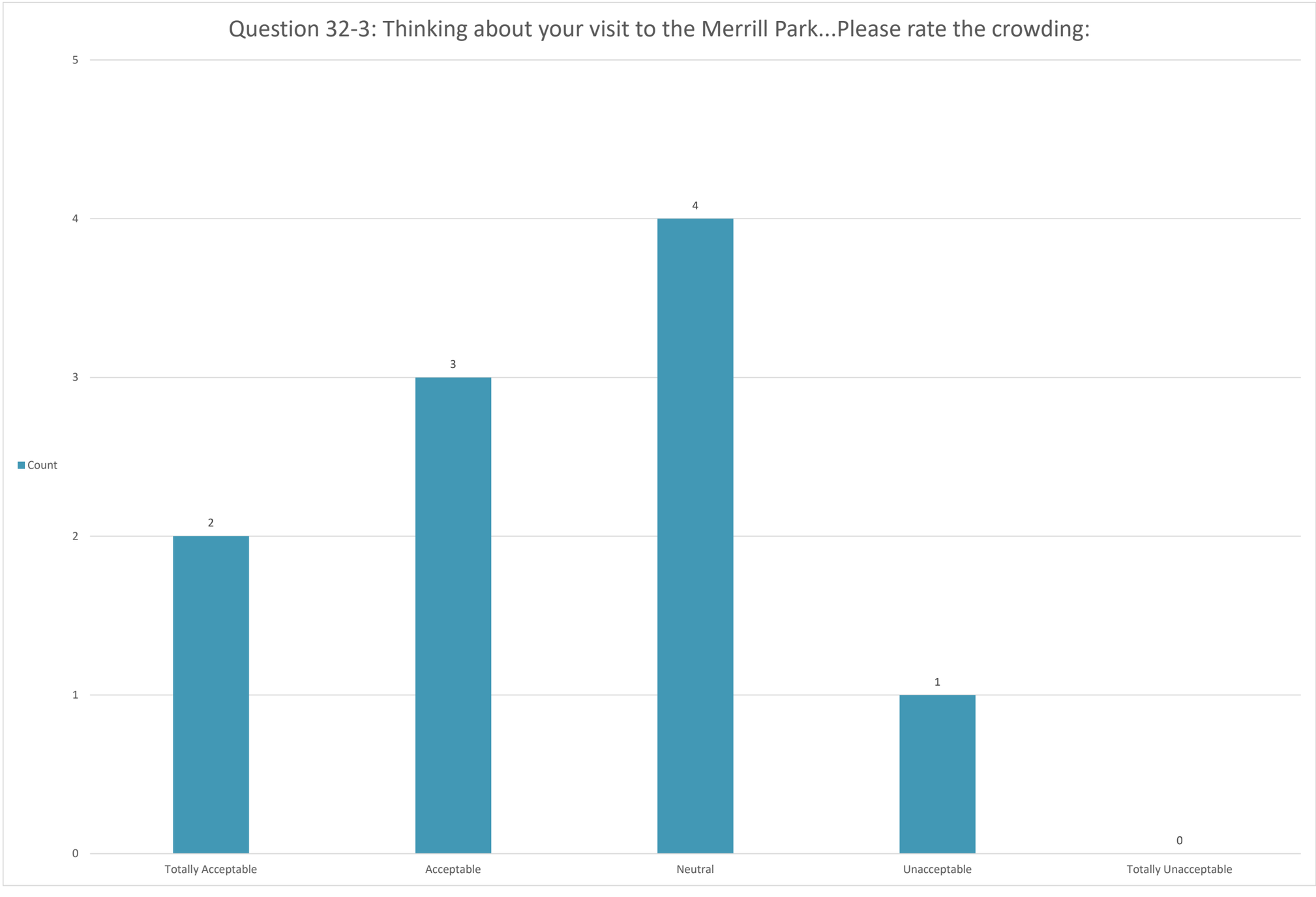

Question 31-6: Thinking about your visit to the Chelmsford Boat Access...Please rate the available amenities:
Count
4
3
2
1
0
0
0
3
3
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

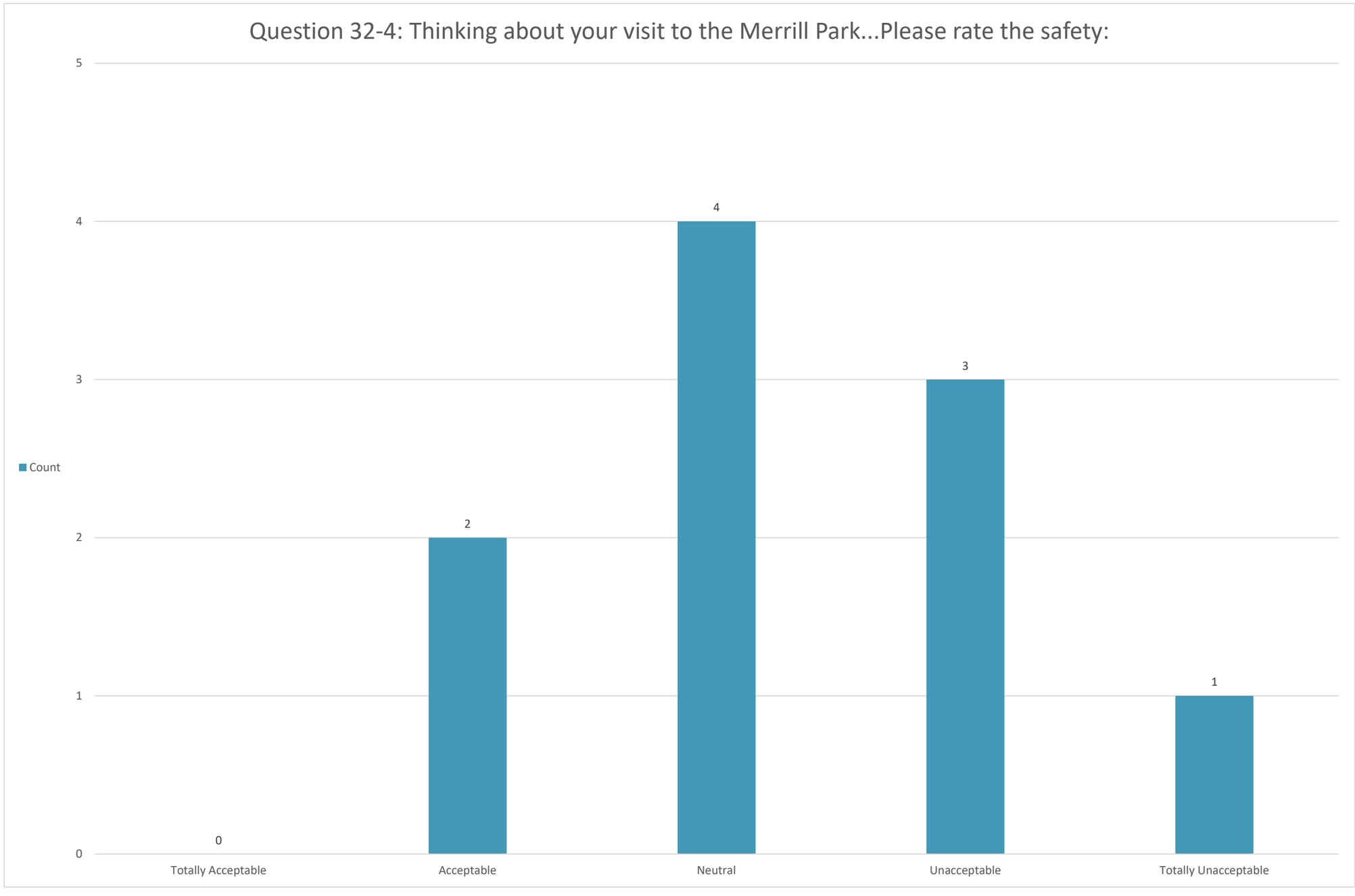

Question 31-7: Thinking about your visit to the Chelmsford Boat Access...Please rate the river flow:
5
4
3
2
1
0
Count
0
3
4
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

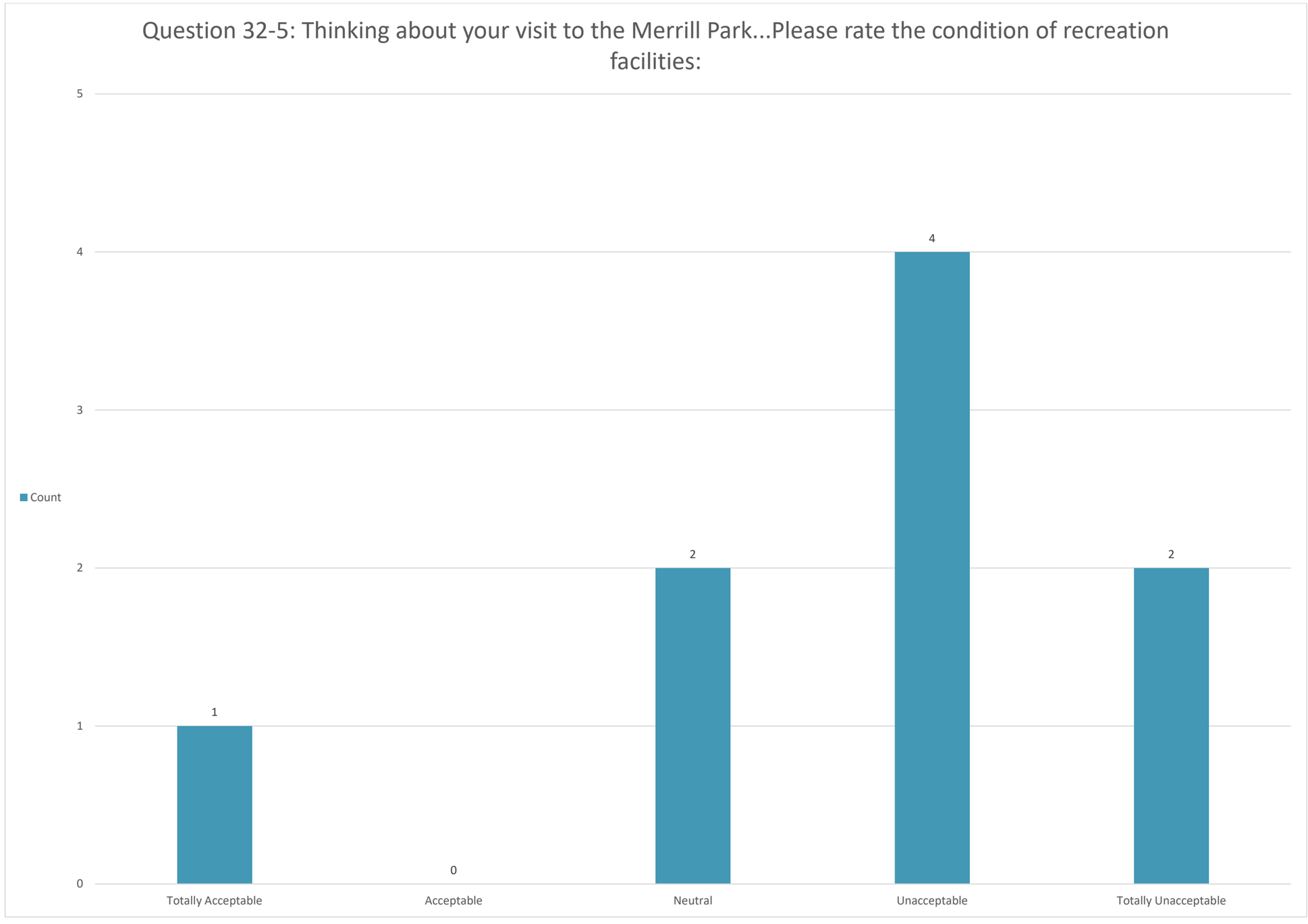

Question 31-8: Thinking about your visit to the Chelmsford Boat Access...Please rate your overall experience:
Count
6
5
4
3
2
1
0
0
2
5
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

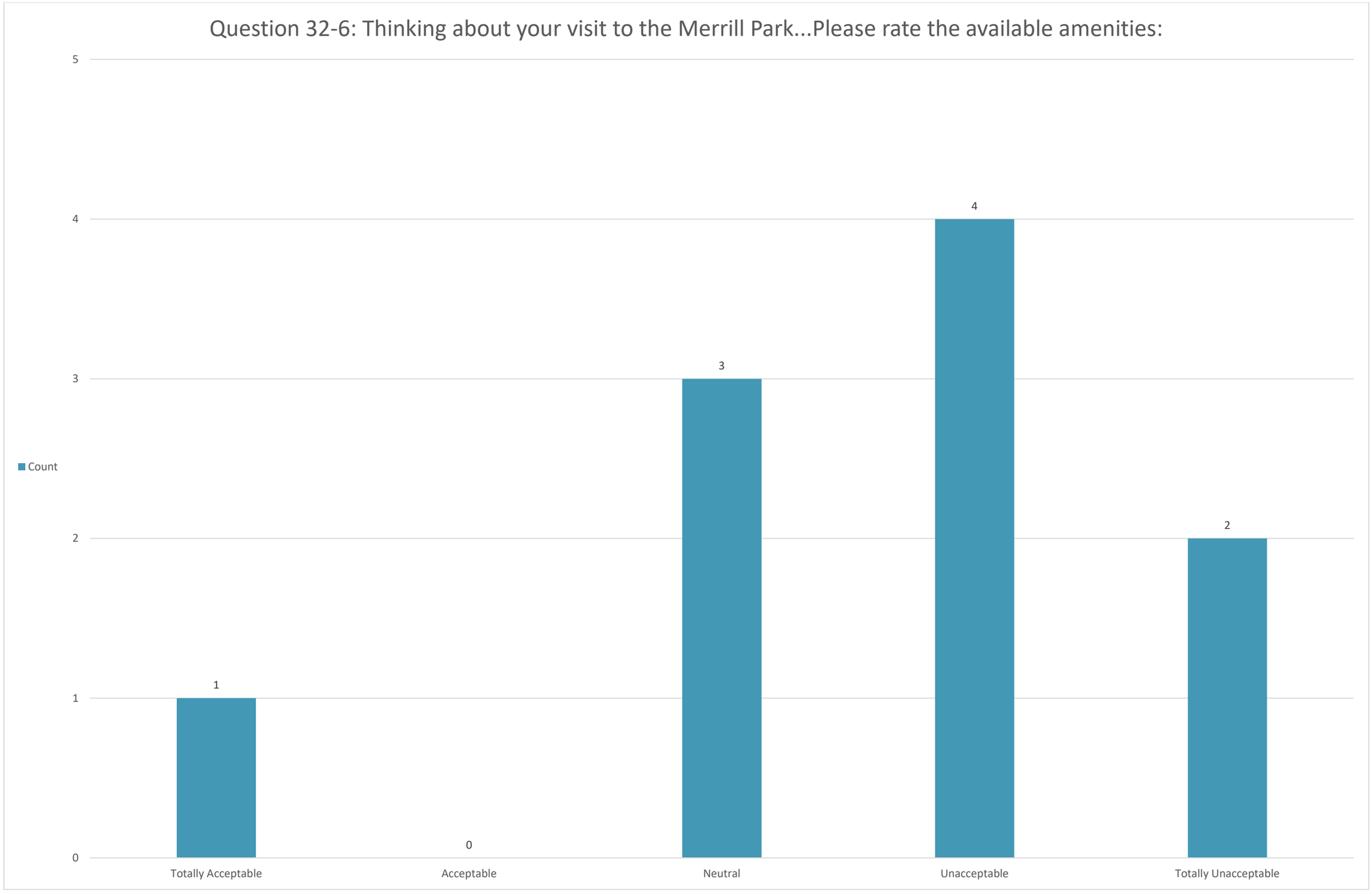

Question 32-1: Thinking about your visit to the Merrill Park...Please rate the accessibility:
5
4
3
2
1
0
Count
1
1
4
2
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

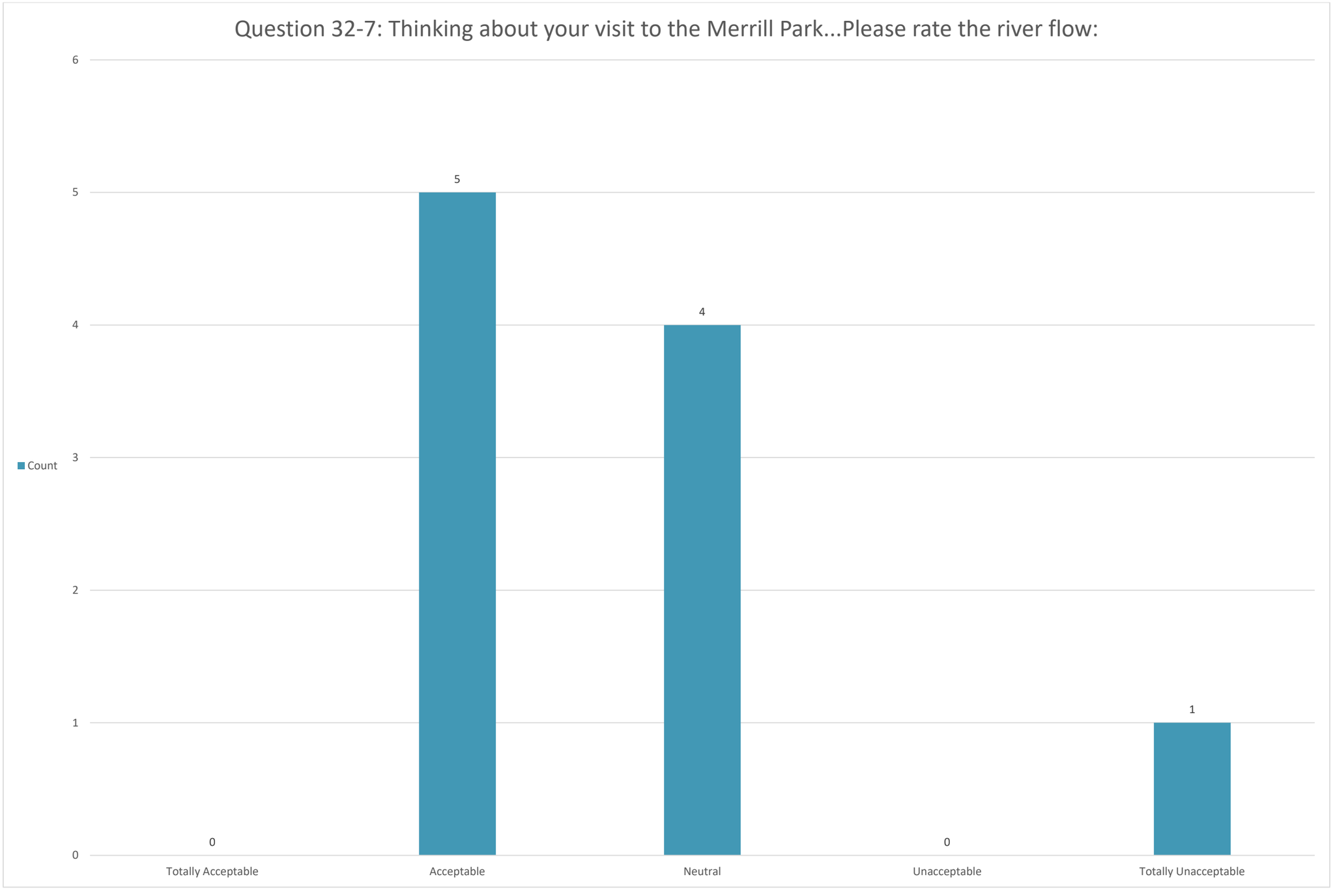

Question 32-2: Thinking about your visit to the Merrill Park...Please rate the parking:
5
4
3
2
1
0
Count
1
3
4
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

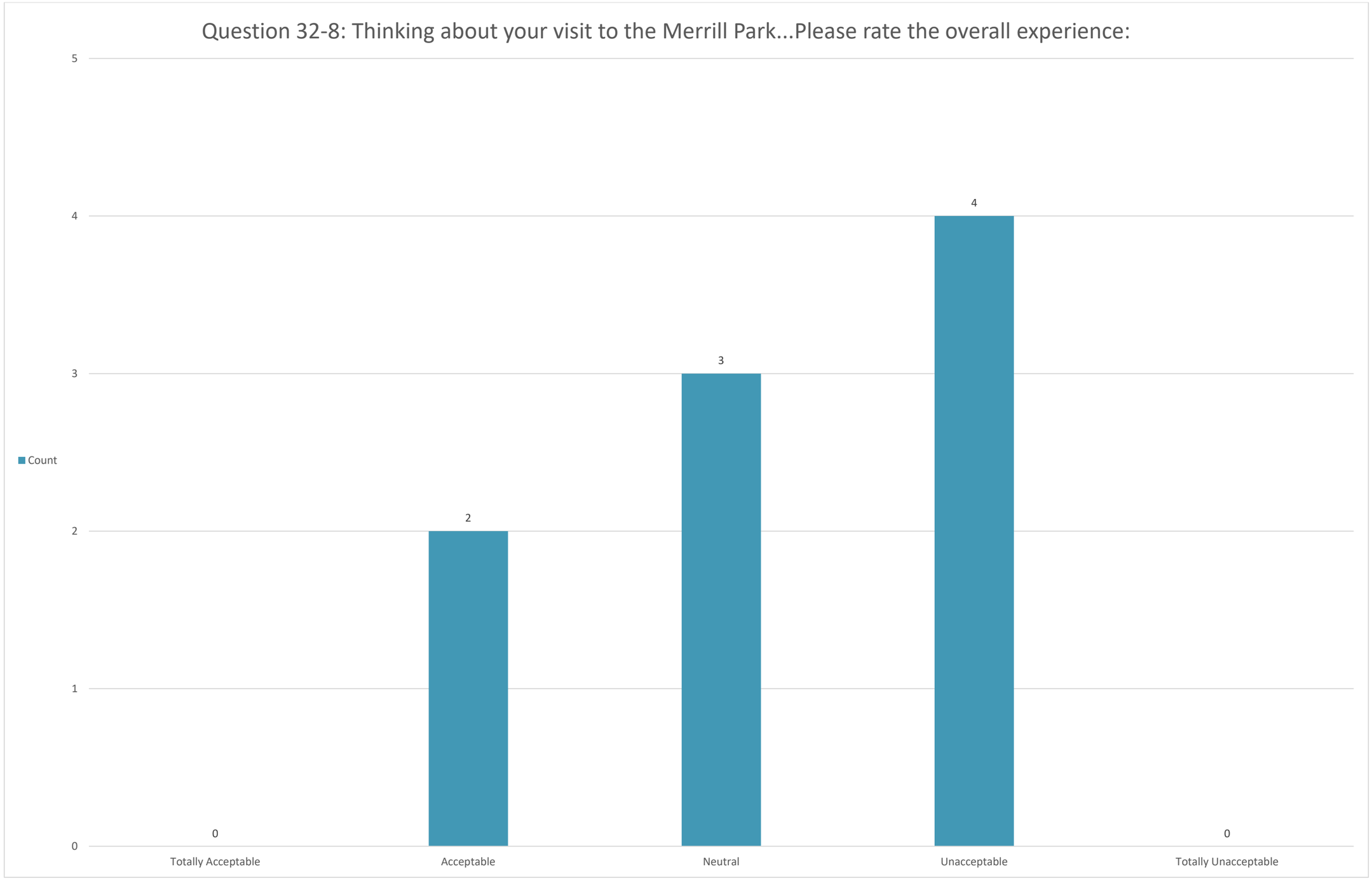

Question 32-3: Thinking about your visit to the Merrill Park...Please rate the crowding:
5
4
3
2
1
0
Count
2
3
4
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

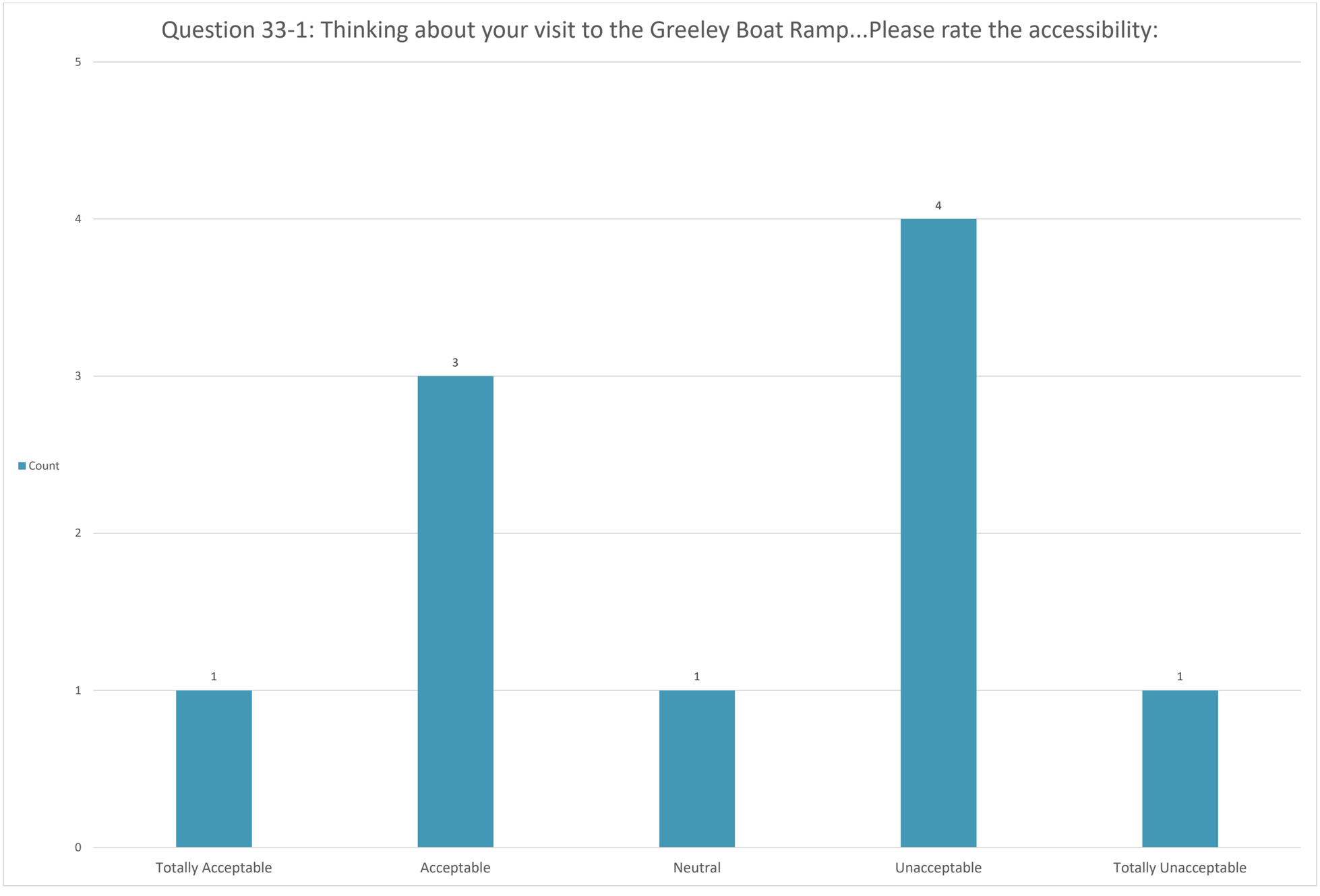

Question 32-4: Thinking about your visit to the Merrill Park...Please rate the safety:
5
4
3
2
1
0
Count
0
2
4
3
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

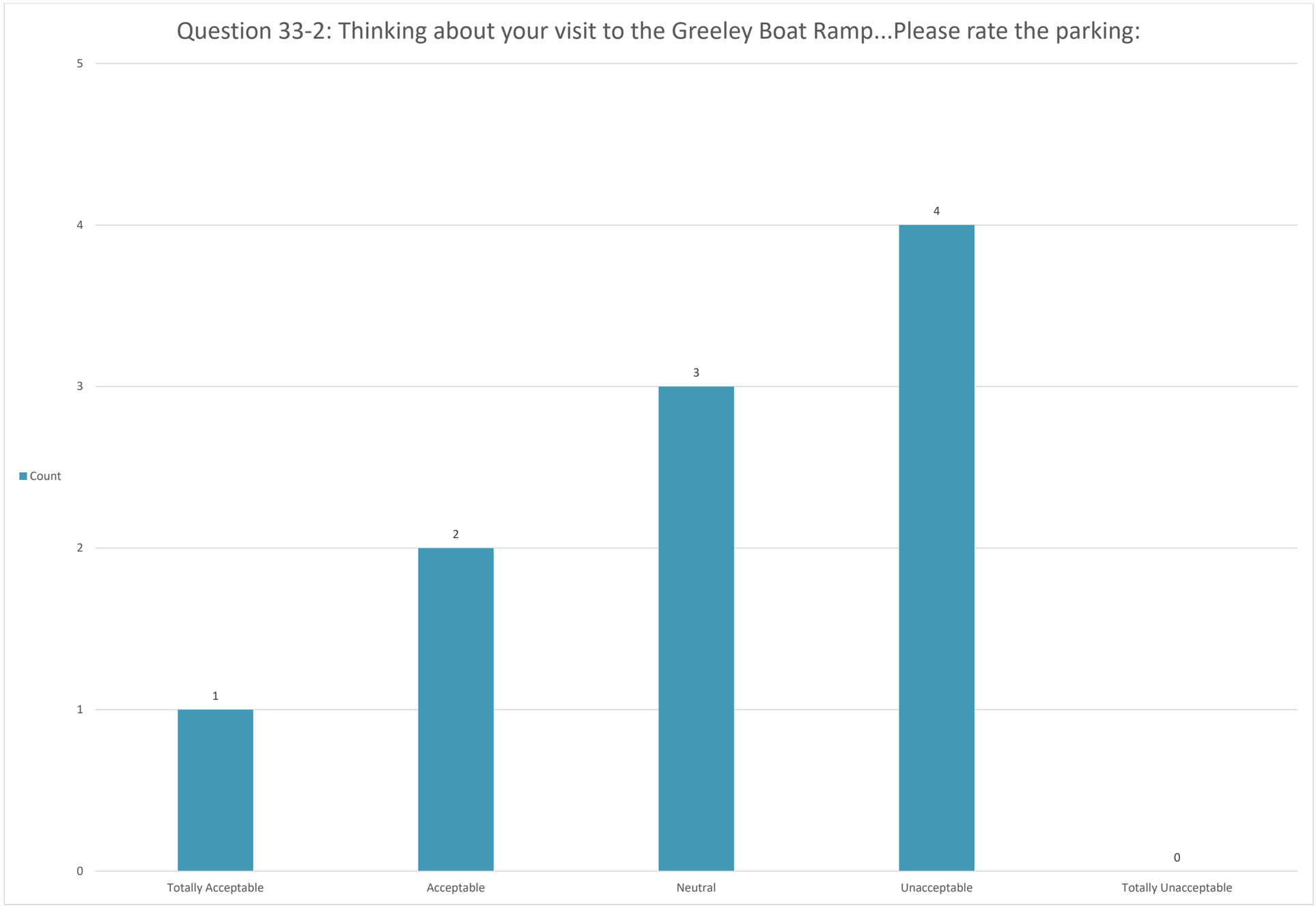

Question 32-5: Thinking about your visit to the Merrill Park...Please rate the condition of recreation facilities:
5
4
3
2
1
0
Count
1
0
2
4
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

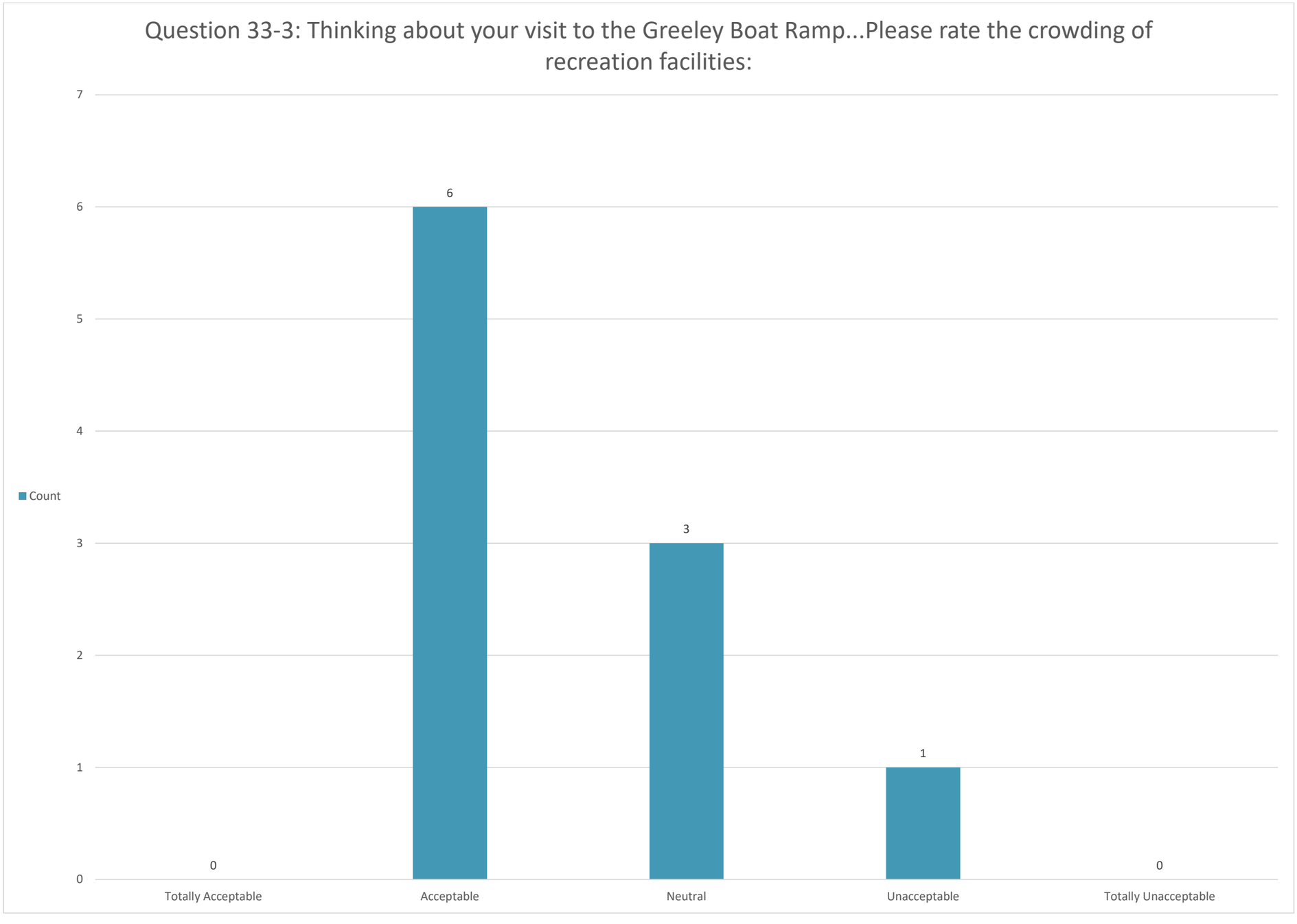

Question 32-6: Thinking about your visit to the Merrill Park...Please rate the available amenities:
5
4
3
2
1
0
Count
1
0
3
4
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

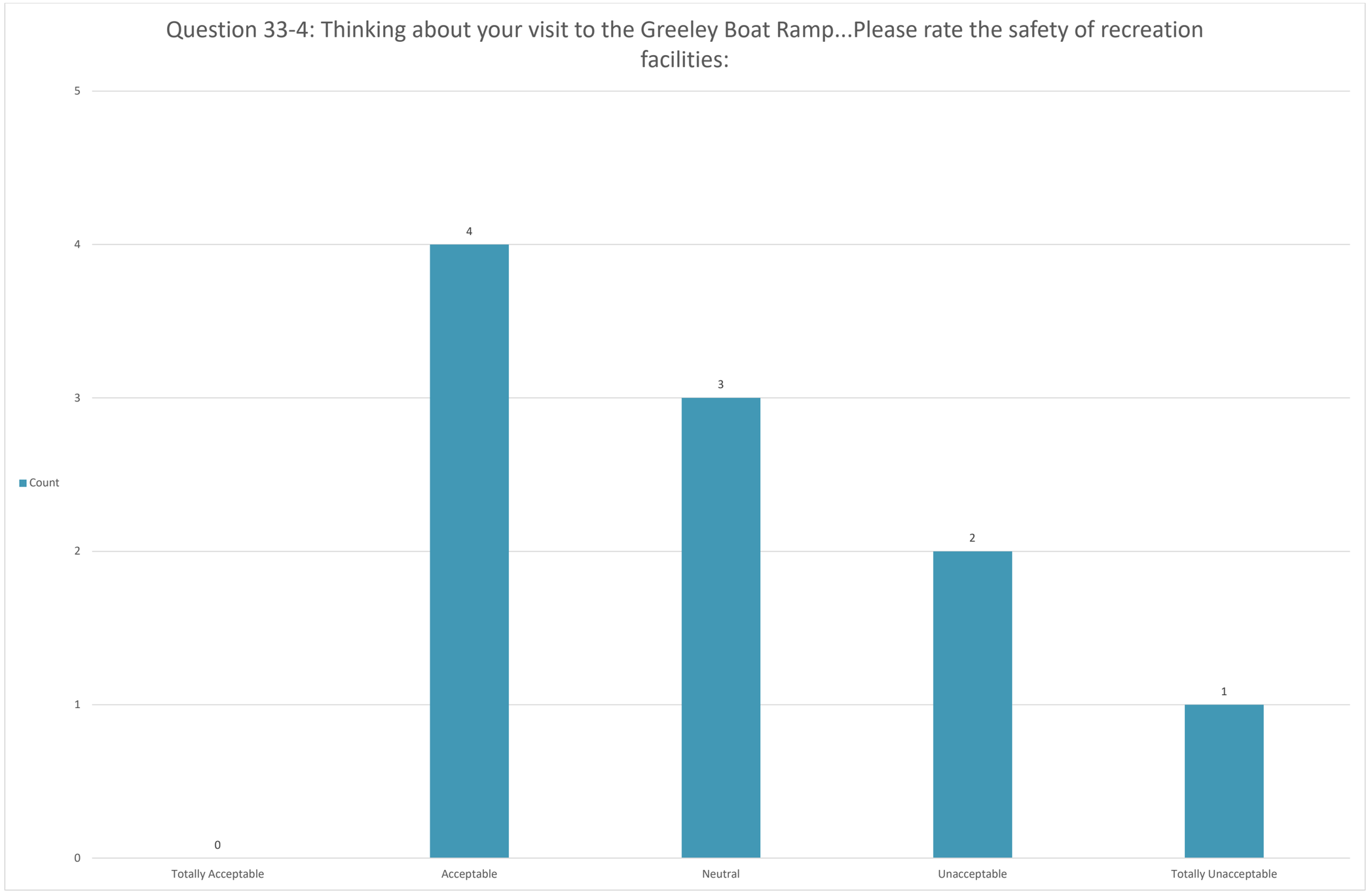

Question 32-7: Thinking about your visit to the Merrill Park...Please rate the river flow:
Count
6
5
4
3
2
1
0
5
4
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

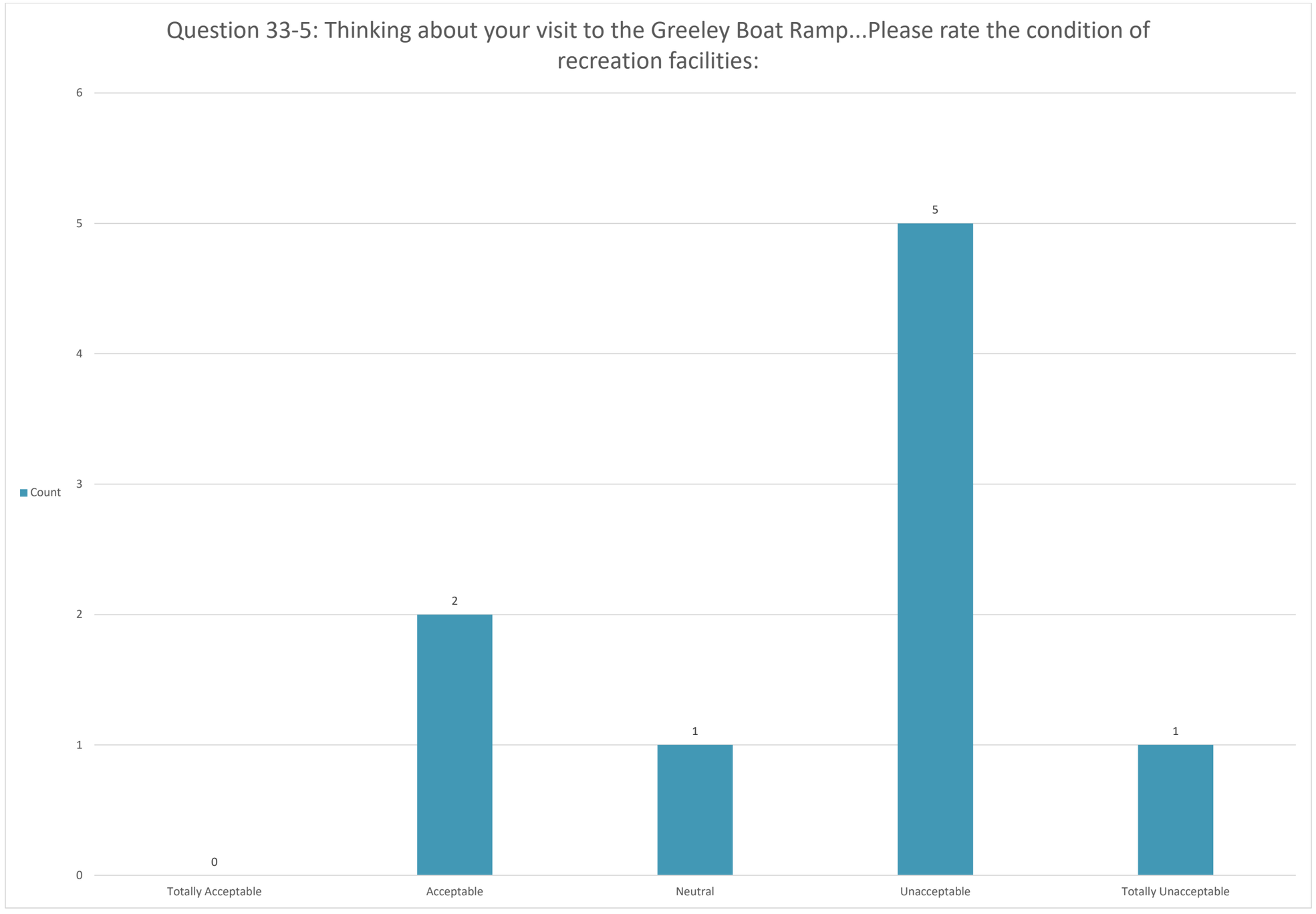

Question 32-8: Thinking about your visit to the Merrill Park...Please rate the overall experience:
5
4
3
2
1
0
Count
0
2
3
4
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

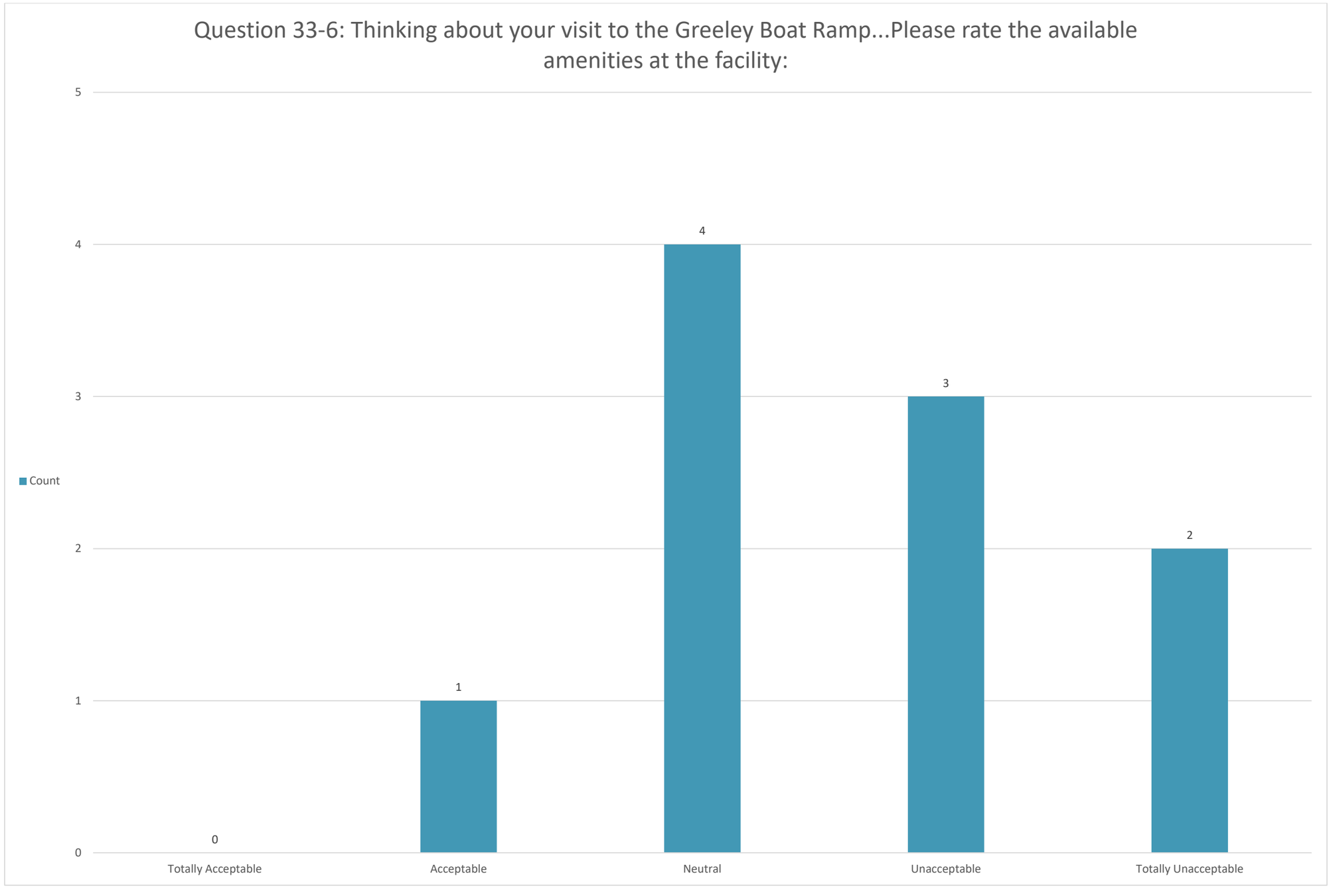

Question 33-1: Thinking about your visit to the Greeley Boat Ramp...Please rate the accessibility:
5
4
3
2
1
0
Count
1
3
1
4
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

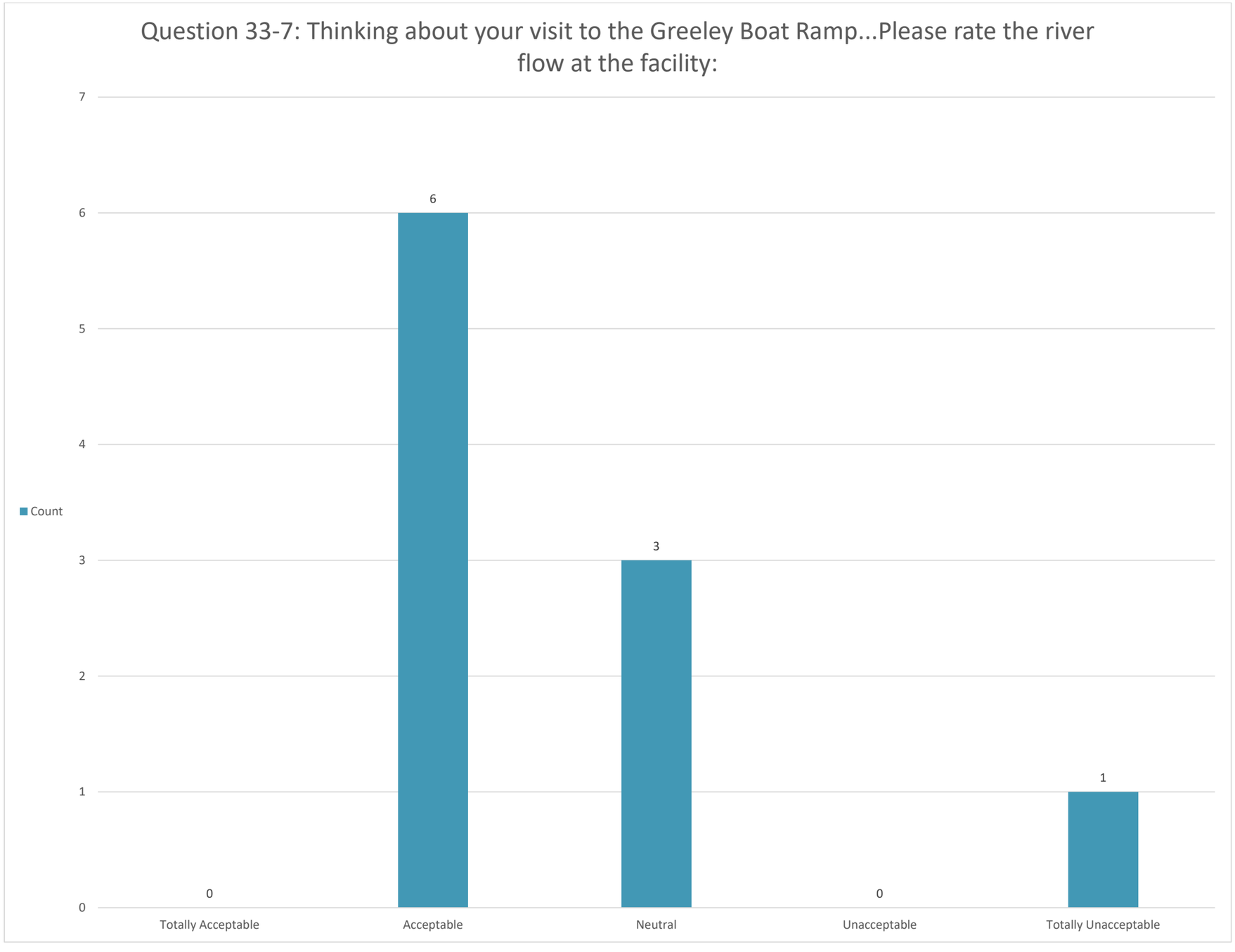

Question 33-2: Thinking about your visit to the Greeley Boat Ramp...Please rate the parking:
Count
5
4
3
2
1
0
1
2
3
4
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

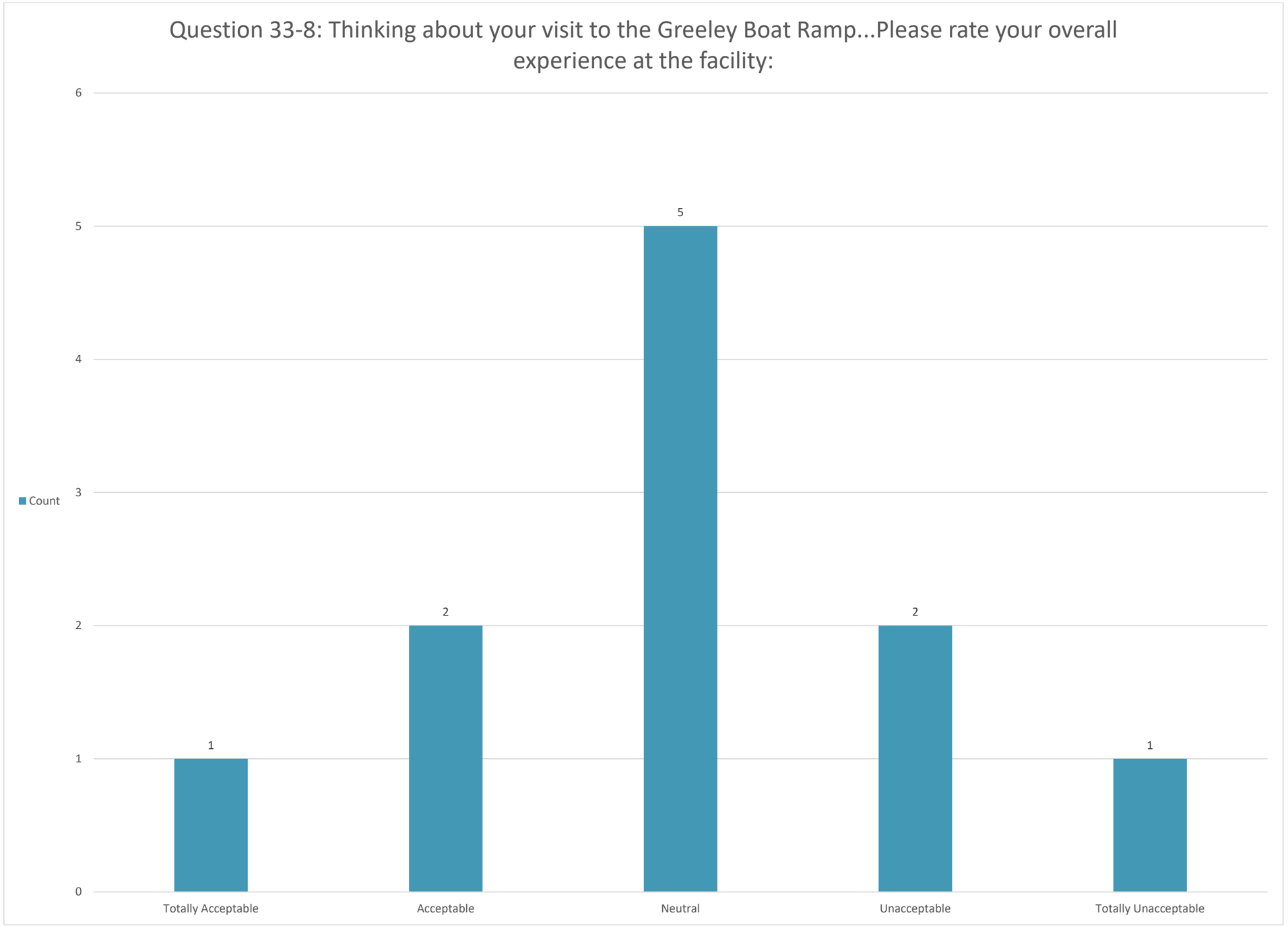

Question 33-3: Thinking about your visit to the Greeley Boat Ramp...Please rate the crowding of recreation facilities:
7
6
5
4
3
2
1
0
Count
0
6
3
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

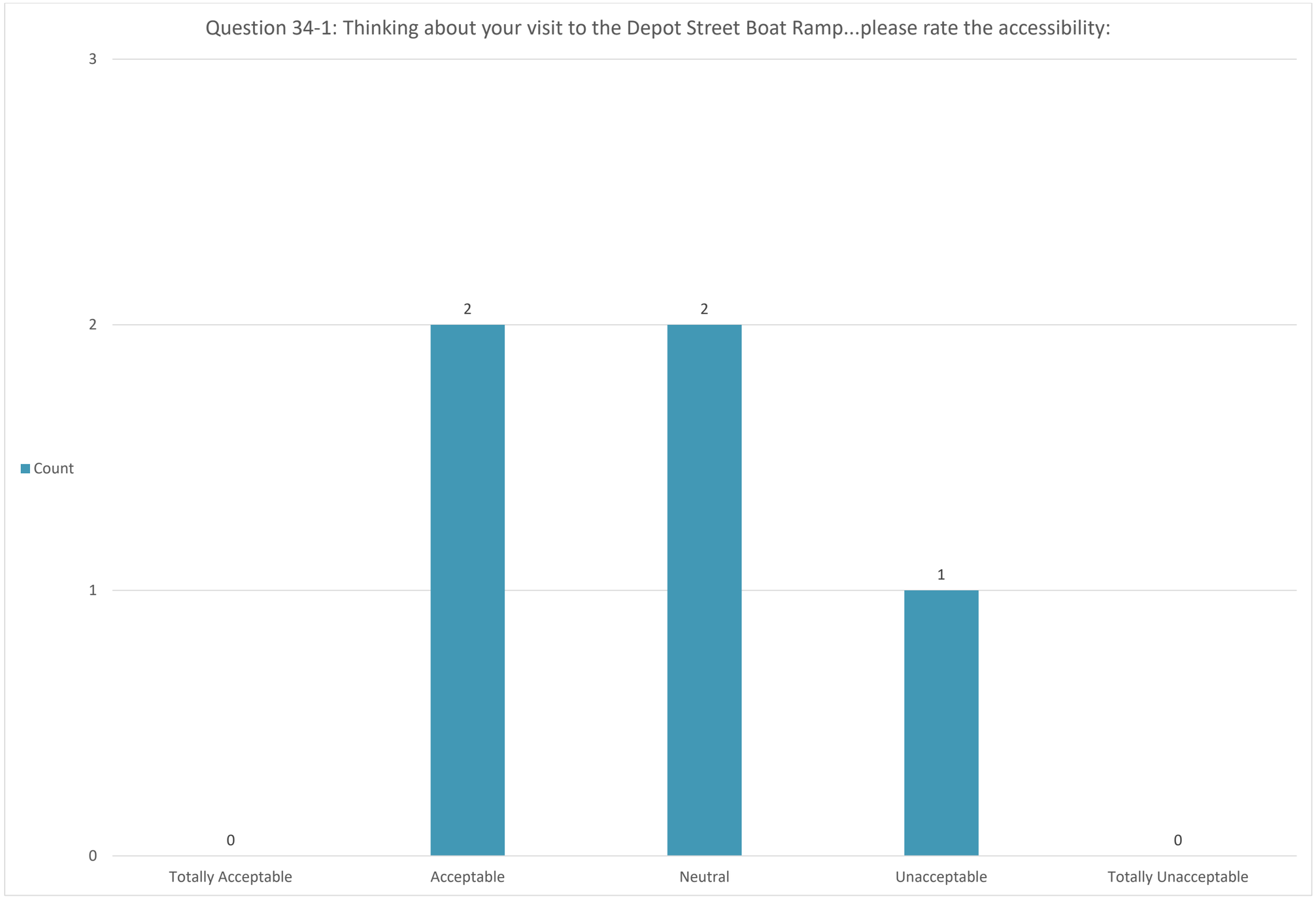

Question 33-4: Thinking about your visit to the Greeley Boat Ramp...Please rate the safety of recreation facilities:
5
4
3
2
1
0
Count
0
4
3
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

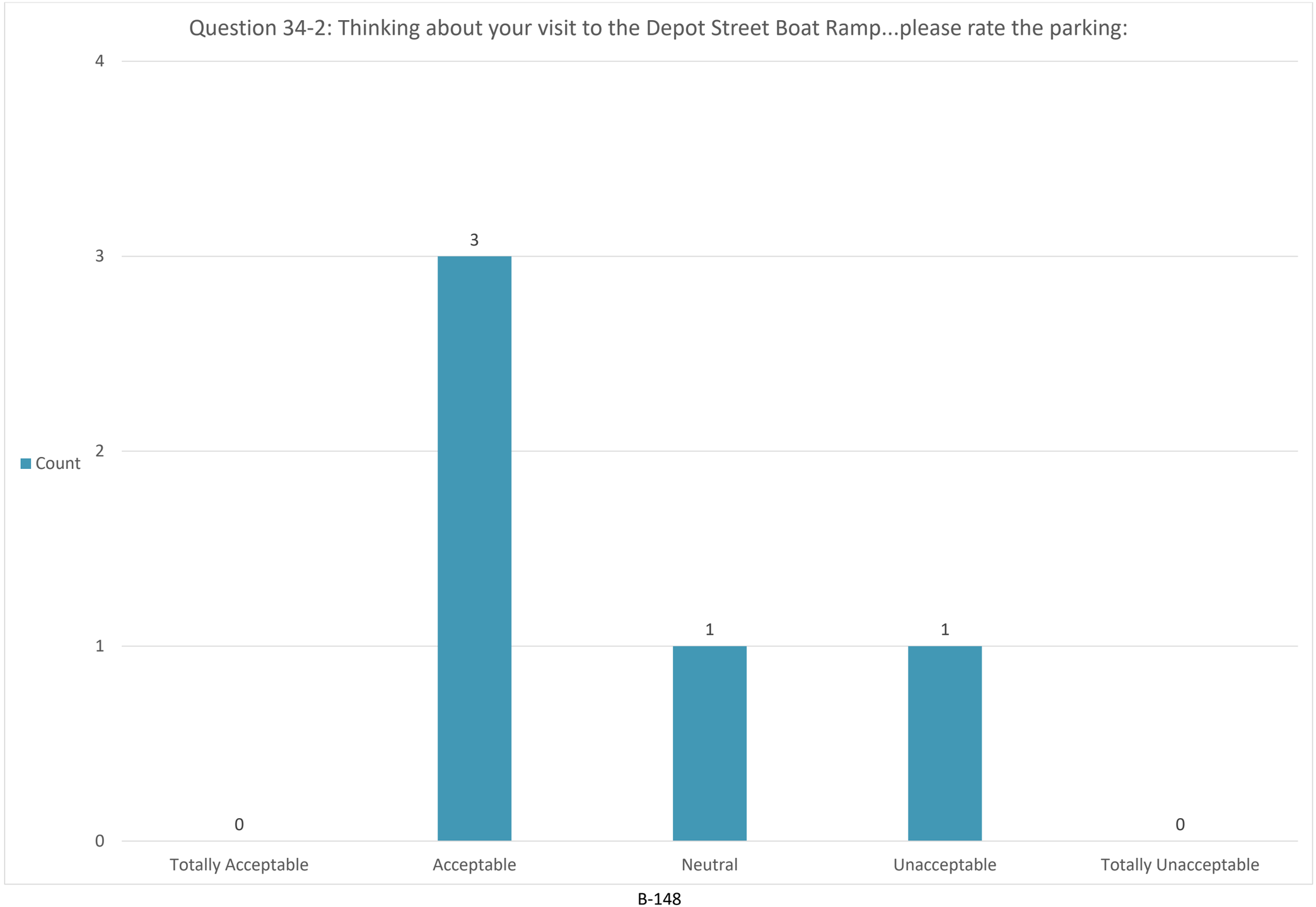

Question 33-5: Thinking about your visit to the Greeley Boat Ramp...Please rate the condition of recreation facilities:
Count
6
5
4
3
2
1
0
0
2
1
5
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

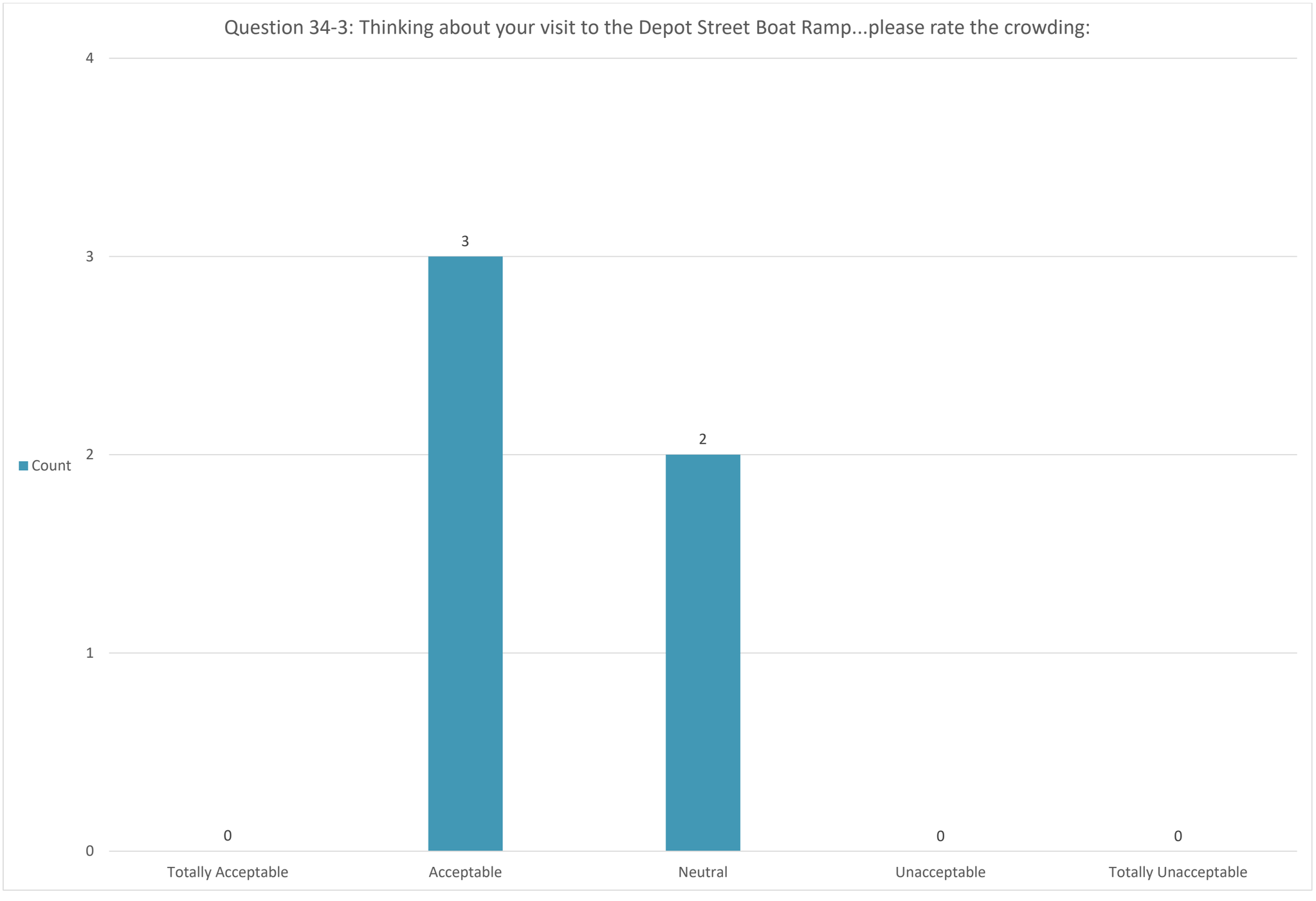

Question 33-6: Thinking about your visit to the Greeley Boat Ramp...Please rate the available amenities at the facility:
5
4
3
2
1
0
Count
0
1
4
3
2
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

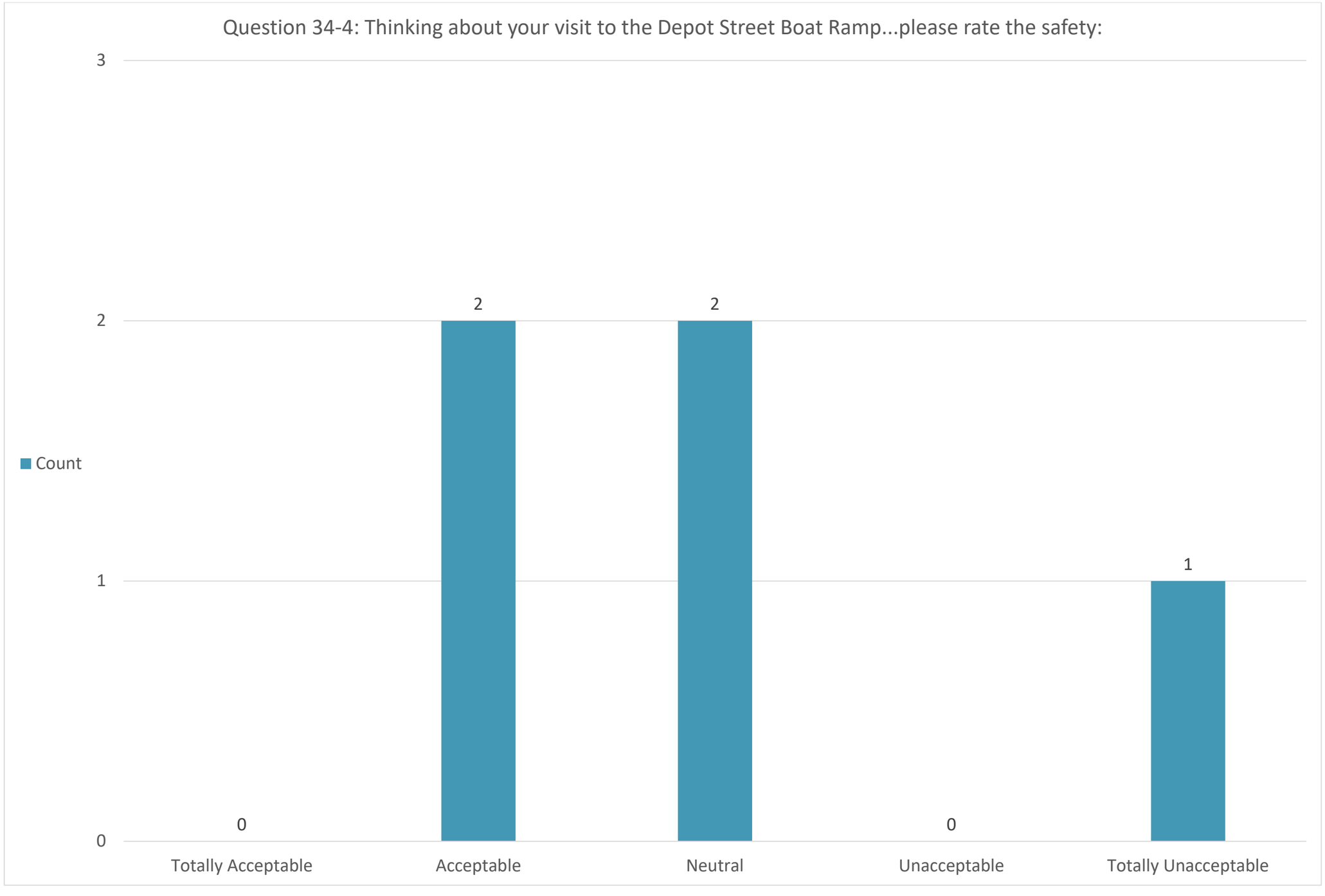

Question 33-7: Thinking about your visit to the Greeley Boat Ramp...Please rate the river flow at the facility:
7
6
5
4
3
2
1
0
Count
6
3
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

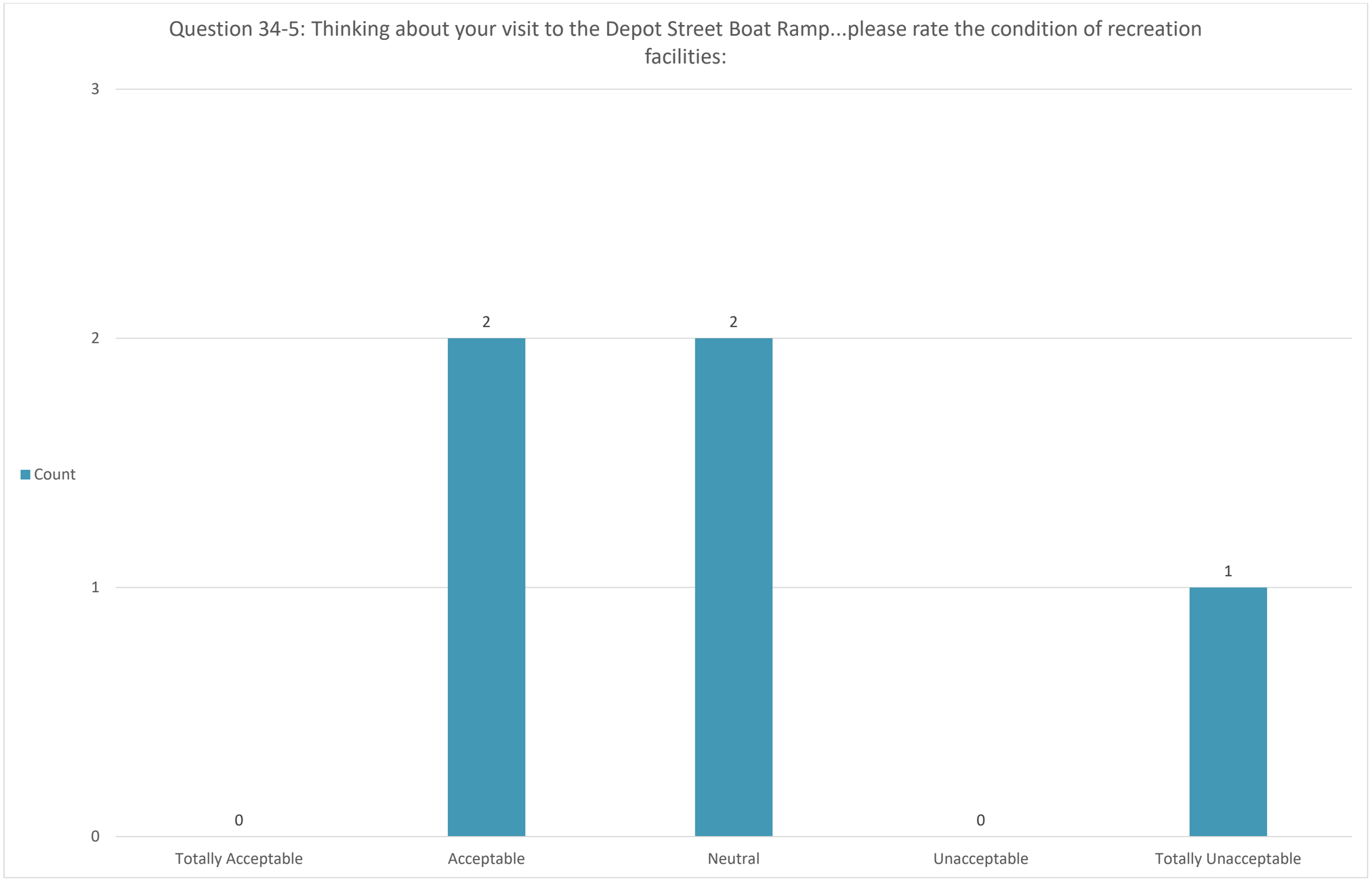

Question 33-8: Thinking about your visit to the Greeley Boat Ramp...Please rate your overall experience at the facility:
Count
6
5
4
3
2
1
0
1
2
5
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

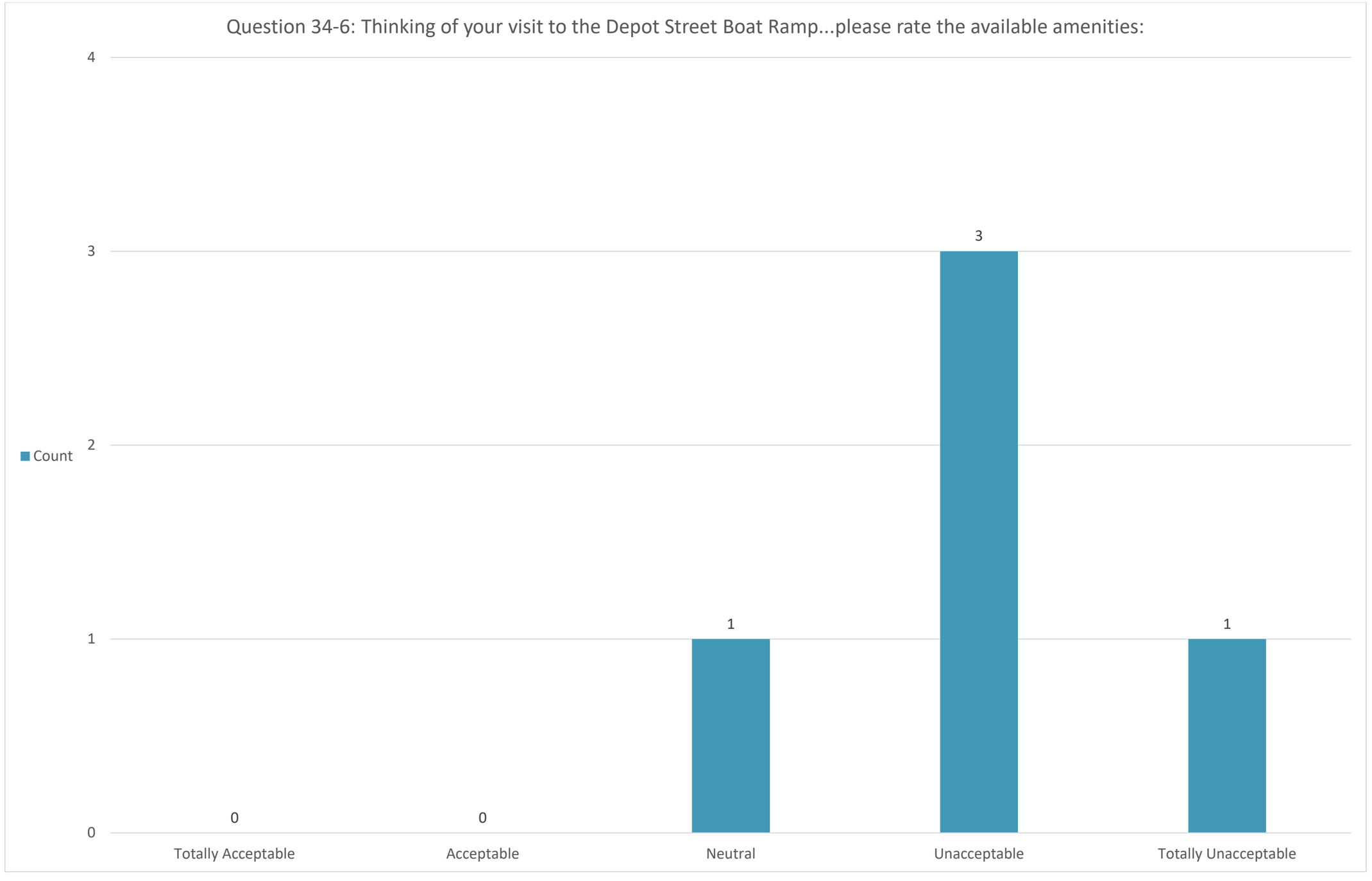

Question 34-1: Thinking about your visit to the Depot Street Boat Ramp...please rate the accessibility:
3
2
1
0
Count
2
2
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

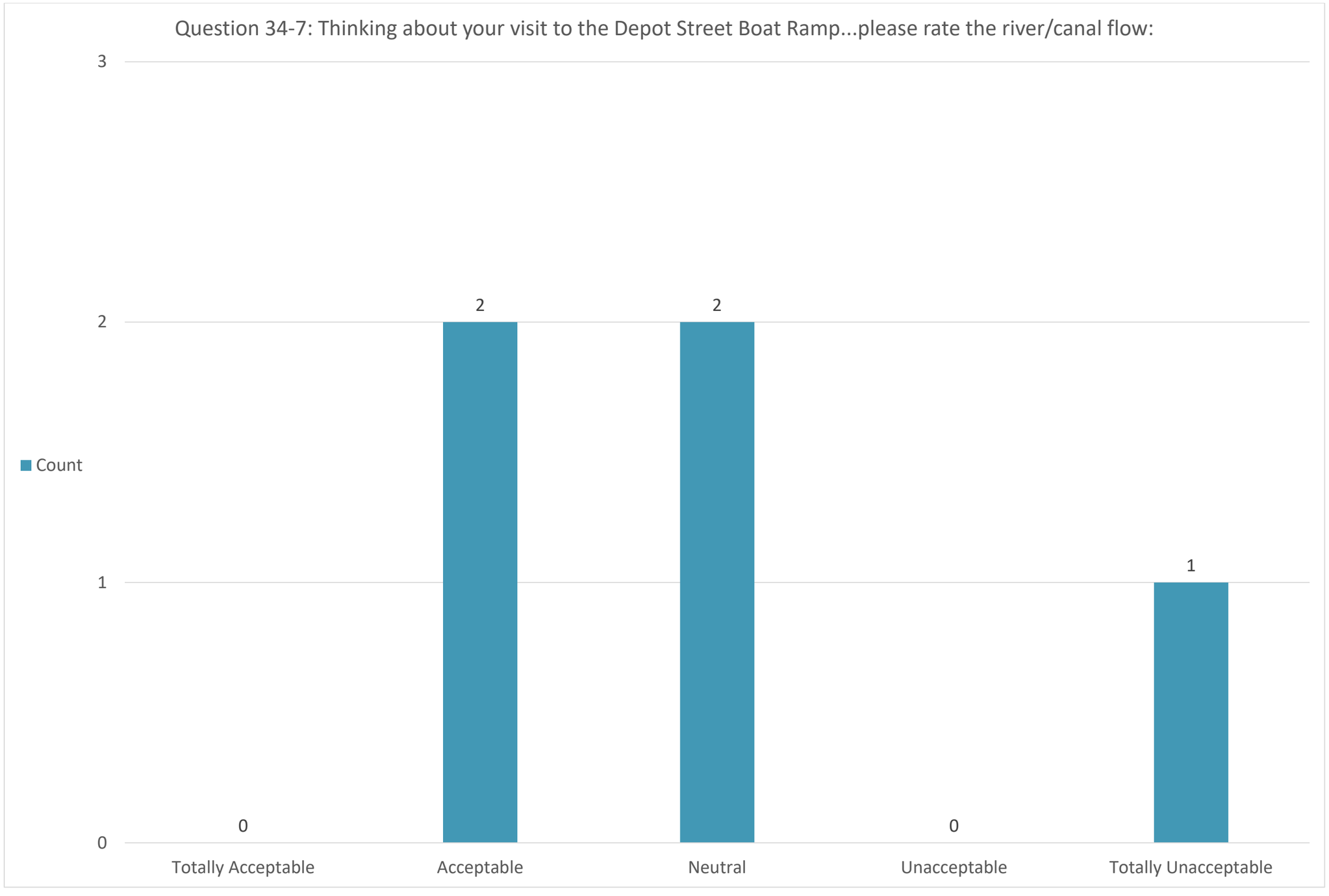

Question 34-2: Thinking about your visit to the Depot Street Boat Ramp...please rate the parking:
4
3
2
1
0
Count
3
1
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

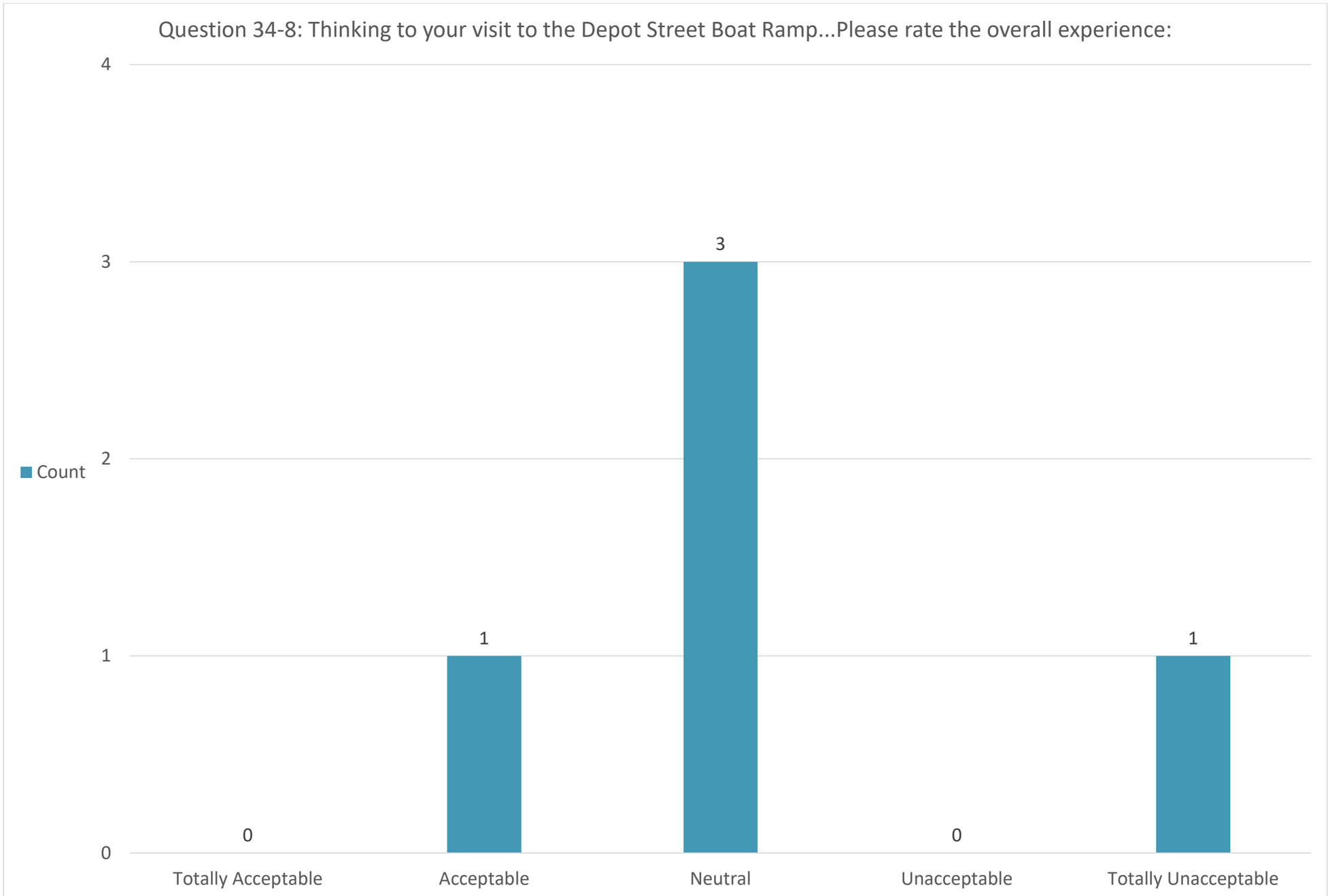

Question 34-3: Thinking about your visit to the Depot Street Boat Ramp...please rate the crowding:
Count
4
3
2
1
0
3
2
0
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

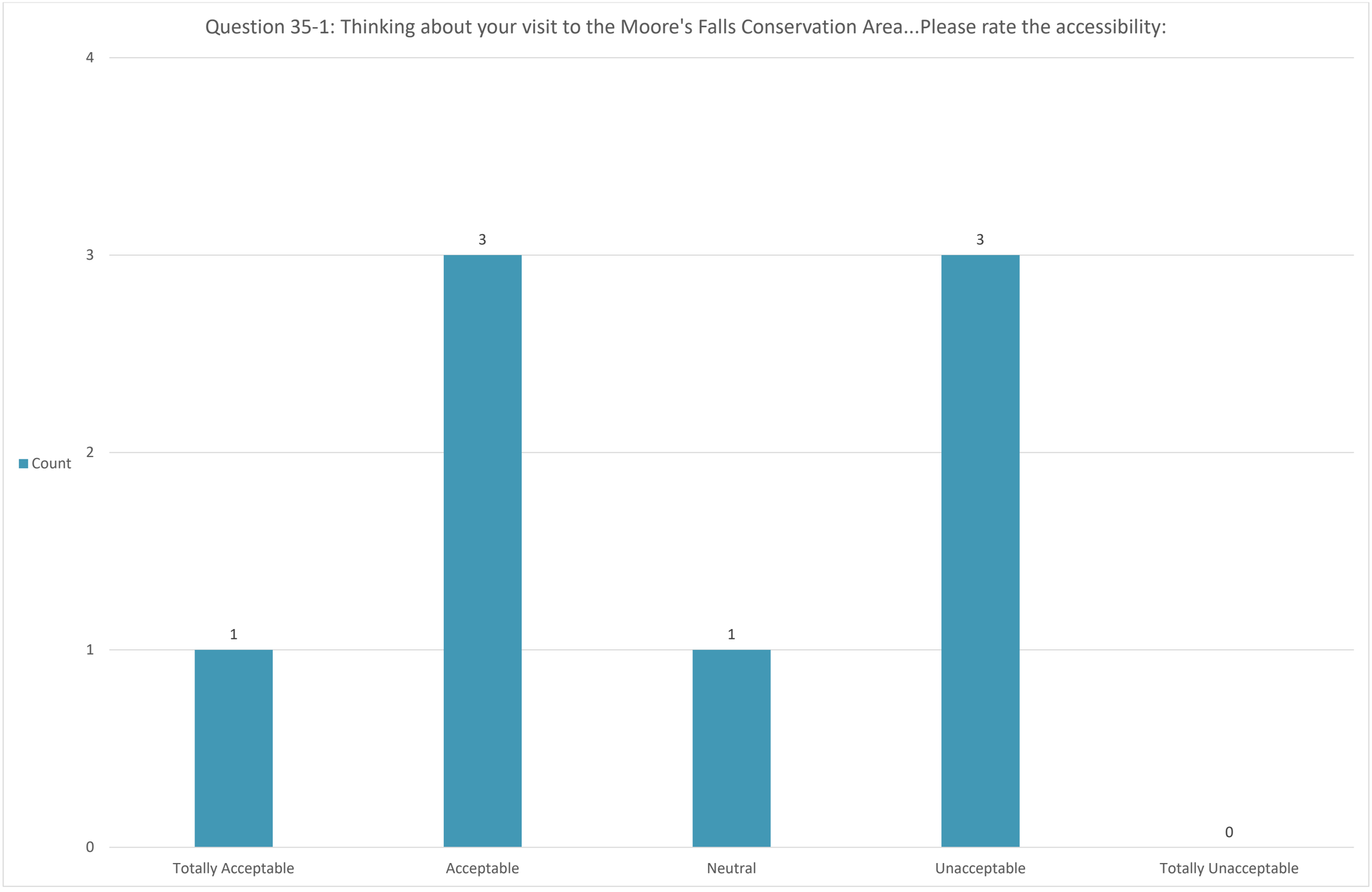

Question 34-4: Thinking about your visit to the Depot Street Boat Ramp...please rate the safety:
3
2
1
0
Count
2
2
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

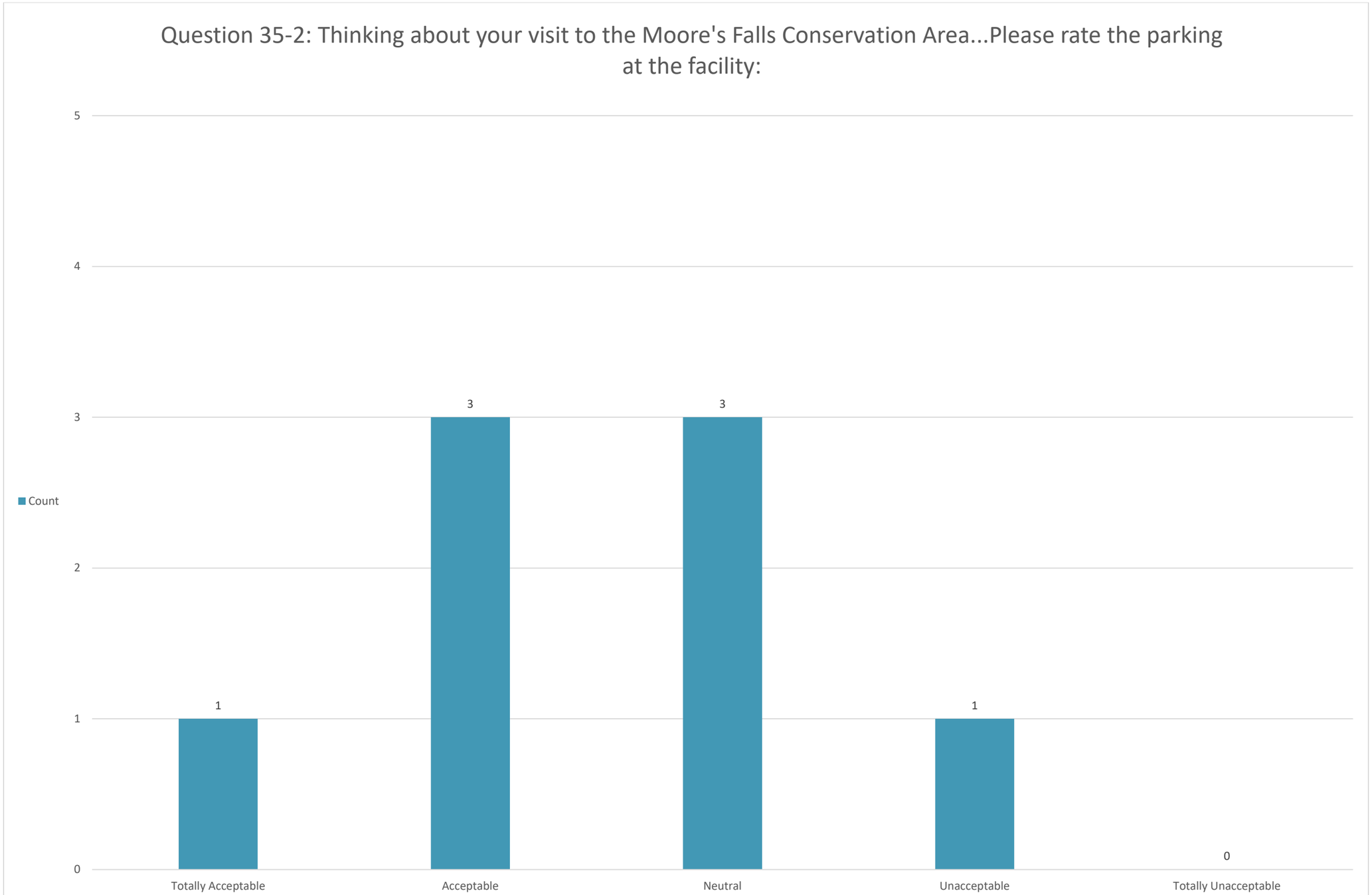

Question 34-5: Thinking about your visit to the Depot Street Boat Ramp...please rate the condition of recreation facilities:
3
2
1
0
Count
2
2
1
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

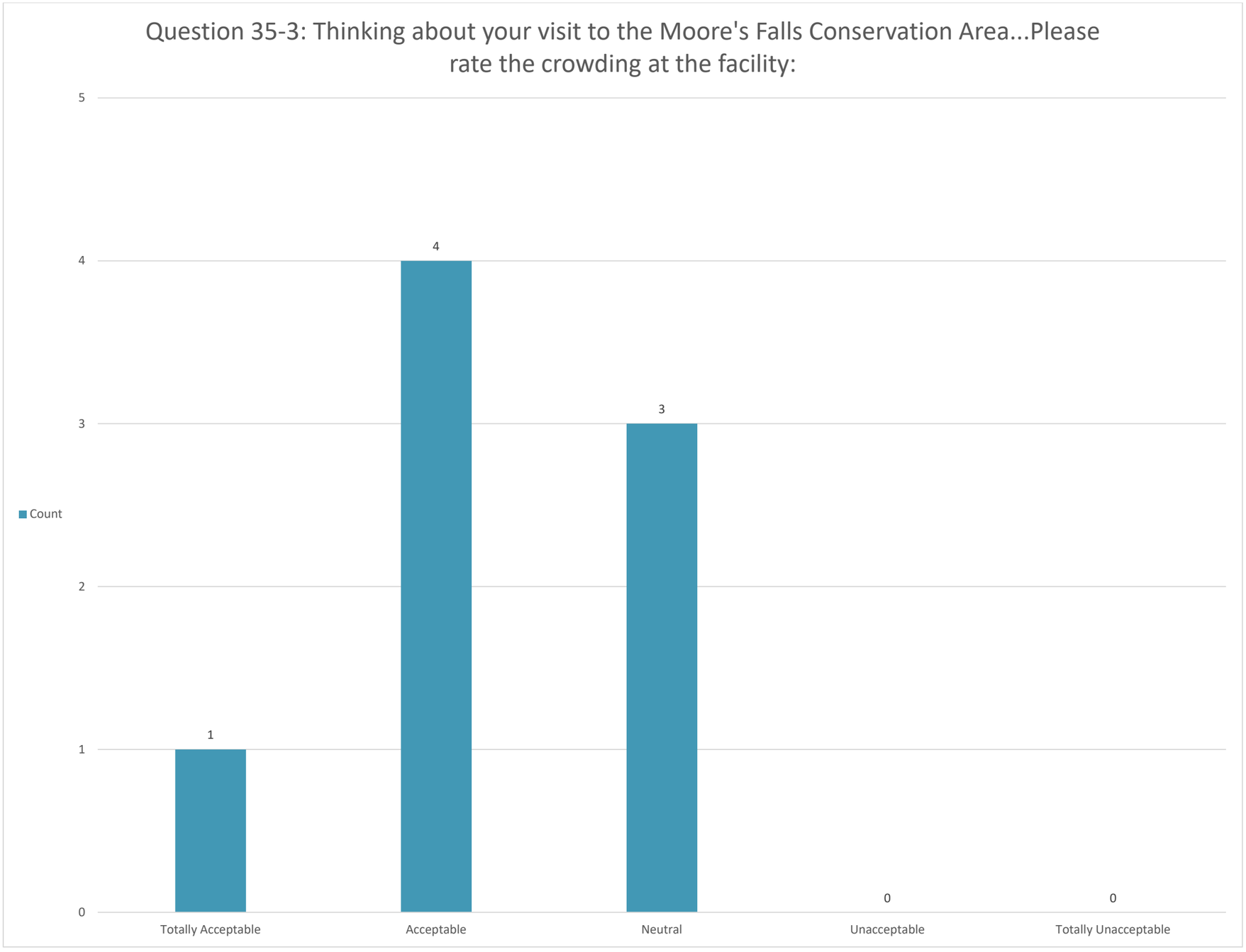

Question 34-6: Thinking of your visit to the Depot Street Boat Ramp...please rate the available amenities:
Count
4
3
2
1
0
0
0
1
3
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

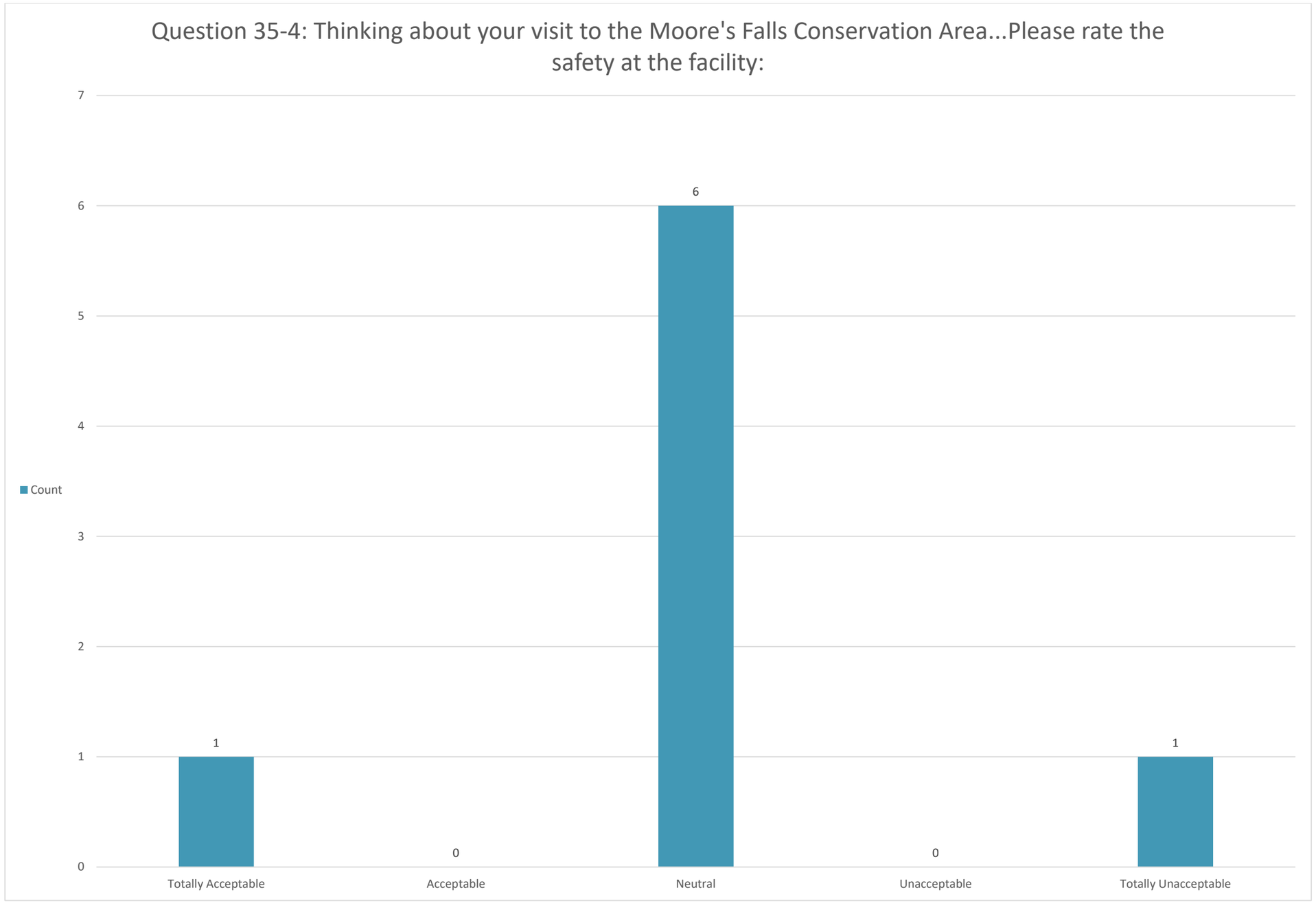

Question 34-7: Thinking about your visit to the Depot Street Boat Ramp...please rate the river/canal flow:
3
2
1
0
Count
0
2
2
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

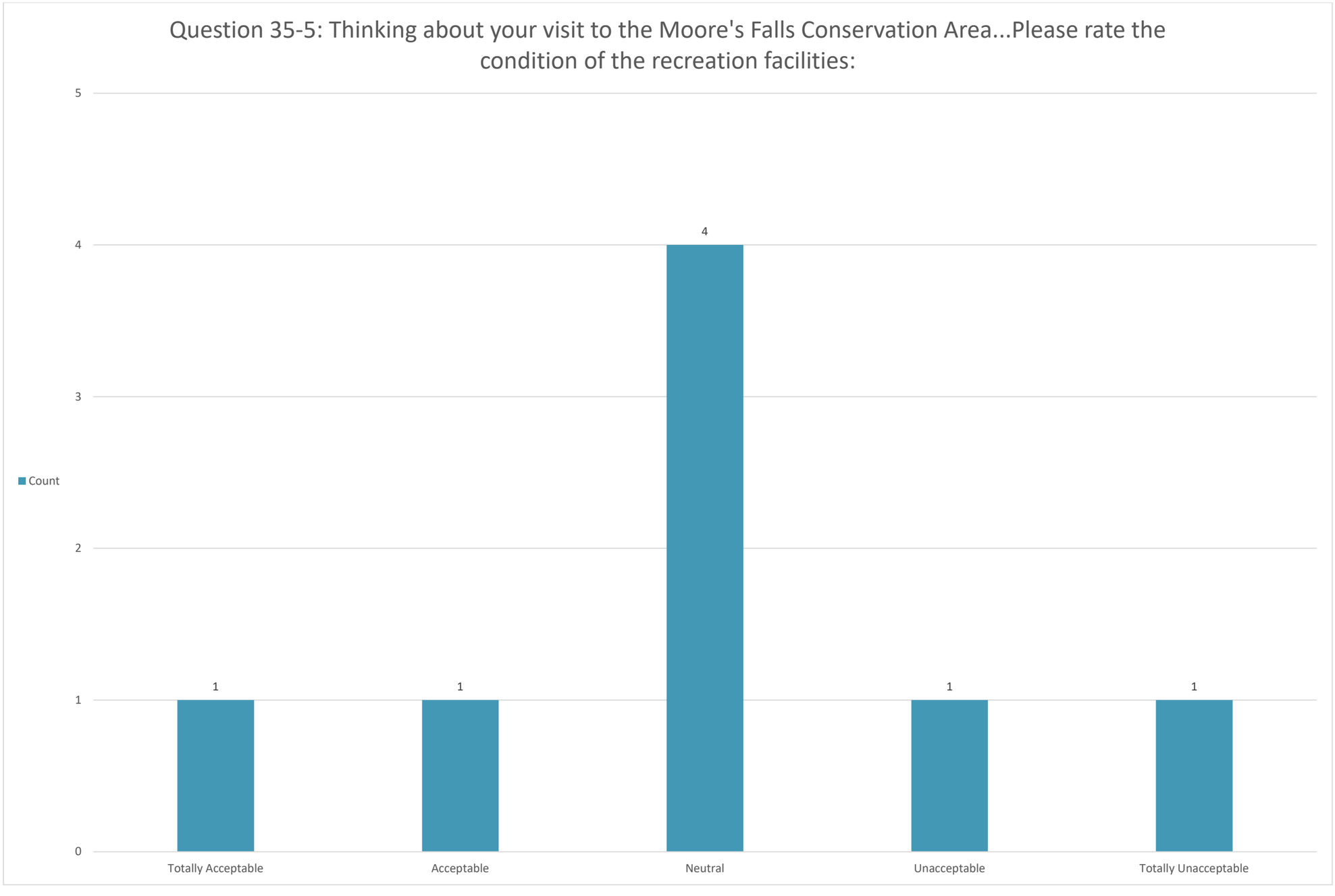

Question 34-8: Thinking to your visit to the Depot Street Boat Ramp...Please rate the overall experience:
Count
4
3
2
1
0
0
1
3
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

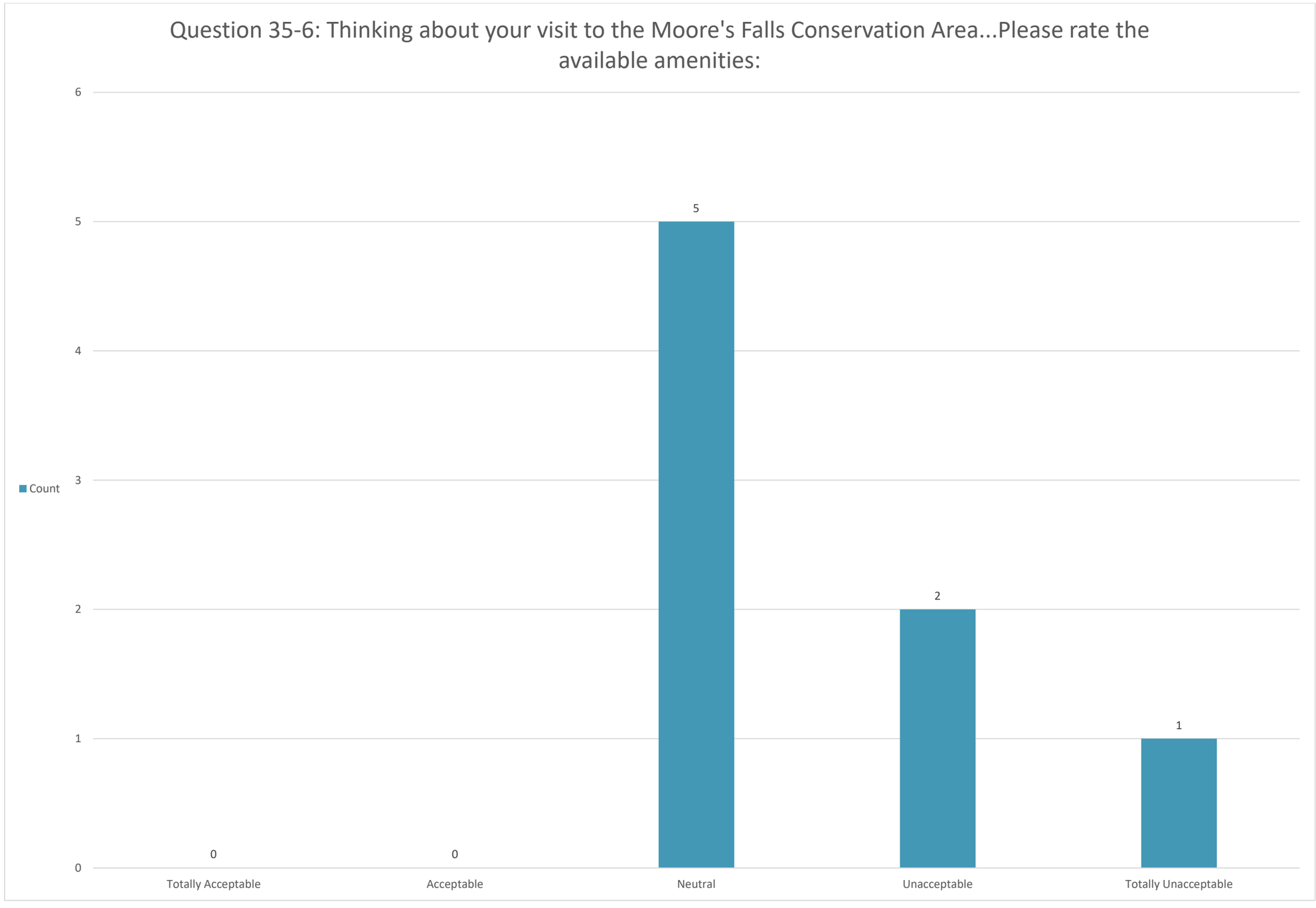

Question 35-1: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the accessibility:
Count
4
3
2
1
0
1
3
1
3
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

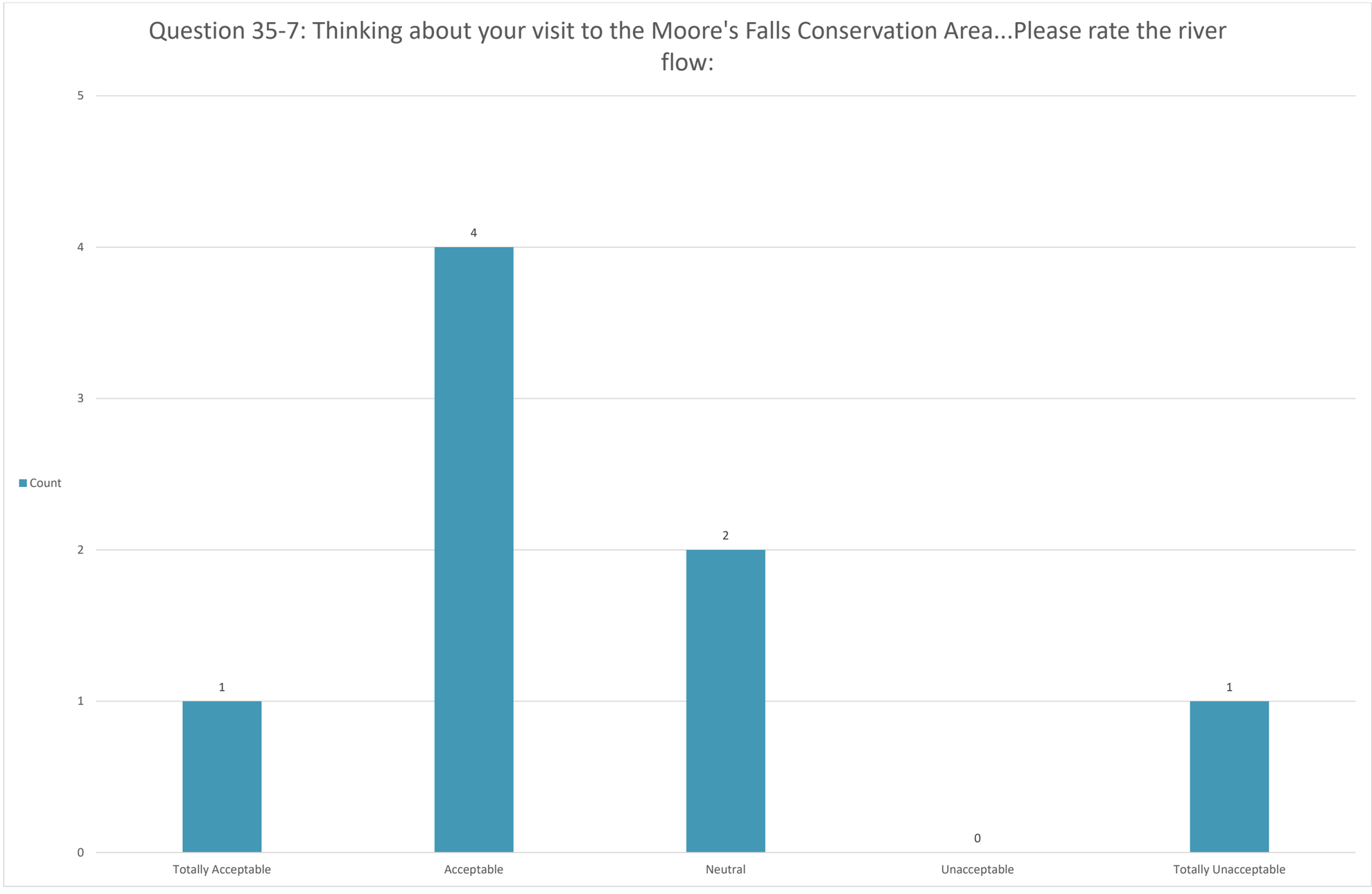

Question 35-2: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the parking at the facility:
5
4
3
2
1
0
Count
1
3
3
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

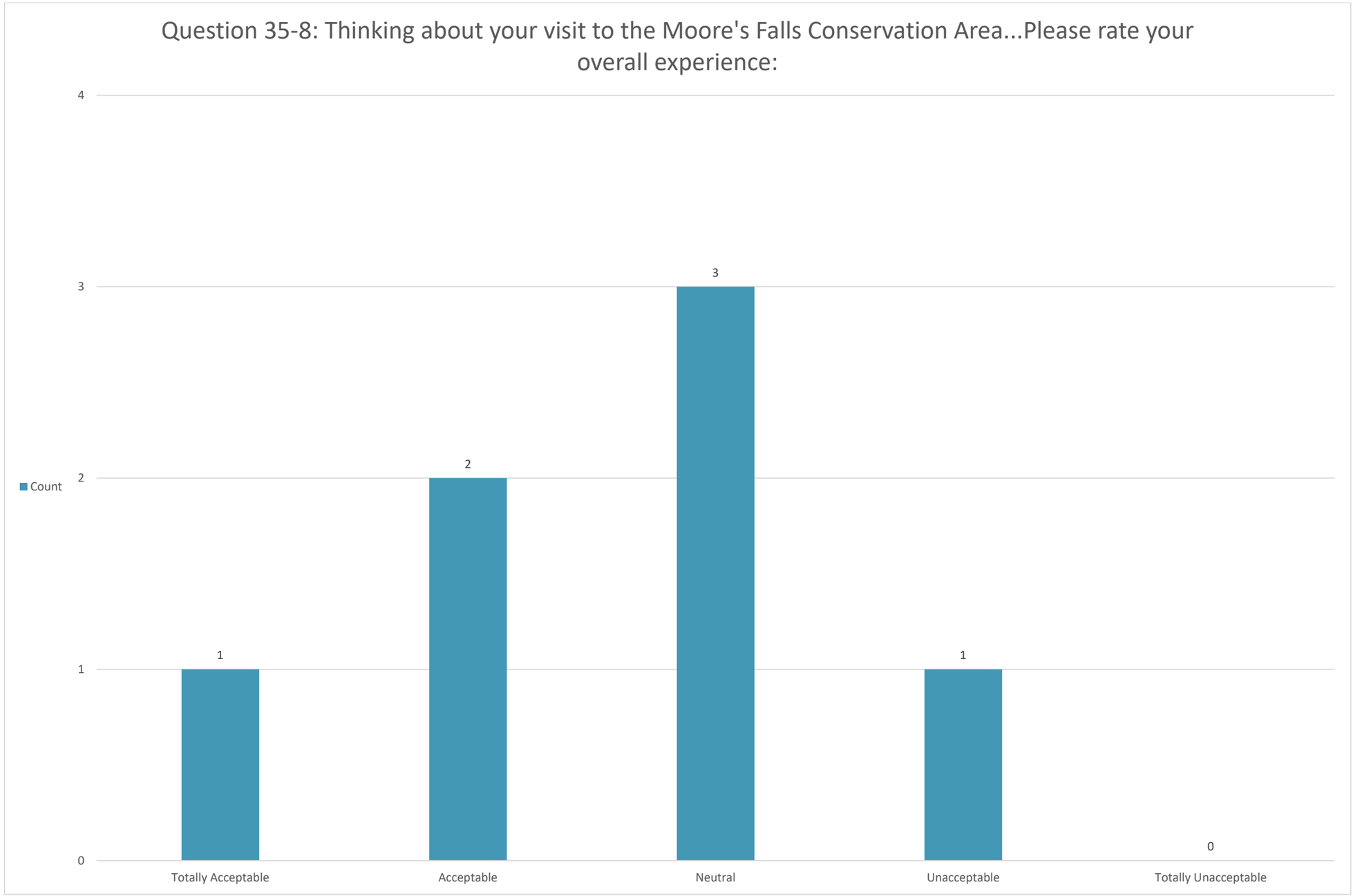

Question 35-3: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the crowding at the facility:
5
4
3
2
1
0
Count
1
4
3
0
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 35-4: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the safety at the facility:
Count
7
6
5
4
3
2
1
0
1
0
6
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 35-5: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the condition of the recreation facilities:
5
4
3
2
1
0
Count
1
1
4
1
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 35-6: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the available amenities:
Count
6
5
4
3
2
1
0
0
0
5
2
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 35-7: Thinking about your visit to the Moore's Falls Conservation Area...Please rate the river flow:
5
4
3
2
1
0
Count
1
4
2
0
1
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable


Question 35-8: Thinking about your visit to the Moore's Falls Conservation Area...Please rate your overall experience:
Count
4
3
2
1
0
1
2
3
1
0
Totally Acceptable
Acceptable
Neutral
Unacceptable
Totally Unacceptable

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5/8/2019 7:25	fishing access	Pawtucket falls area	whitewater recreational releases with improved access and adequate flow information	Pawtucket falls	Improved access and trails	Pawtucket falls area	Lowell's world class whitewater and long season, is a resource that is greatly overlooked and underutilized due to the current condition. Whitewater boating is a popular sport in New England with tens of thousands of participants. Many live in the greater Boston area, myself just a few miles. Many Boaters enjoy the rapids on neighboring Concord River. Lowell has potential here to create another unique thriving attraction. Not only to the private boaters but to commercial companies as well. Commercial rafting proceeds on the Concord, currently help fund much of the greenway project. A longer greater season for them means more financial assistance from their proceeds. Lowell should be and has all the potential to be, a Richmond VA of the North.
5/8/2019 8:08	improvements for whitewater paddlers						
5/8/2019 8:53	River access to whitewater sections	Anywhere there is whitewater, in particular just below the dam.					
5/8/2019 9:03	Improved public access to the canals	all canals	better public access for unguided canoeing / kayaking	all canals	public access ramps, parking areas	near canals	It would be fantastic for economic development, waterfront pubs, non-motorized boat rental, to allow public access to Lowell canals - at least from dawn till dusk.
5/8/2019 9:10	Whitewater Access	Pawtucket Falls	Recreational releases	Pawtucket Falls	Proper Flow Gauge for Pawtucket Falls	Pawtucket Falls	I have traveled the country paddling challenging whitewater. Lowell has some of the highest quality whitewater given the correct conditions. However its inaccessibility, lack of flow, and debris problem. Has allowed it

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							to be severely compromised, seldom visited and avoided commercially. Limited shoreline access has also created conditions of underutilized wooded areas, that largely harbor many homeless camps, dumping sites. Further adding to river and shoreline debris. Addressing these recreational potentials will greatly benefit the health of the river and the city as well as help developing Lowells growing recreational attractions.
5/8/2019 9:17							
5/8/2019 9:48							
5/8/2019 9:59	Keep rivers clear of debris and trash including trees	Concord					Good improvements to river putin and takeout locations.
5/8/2019 10:06	Boat ramps	Canals	Kayak and canoe access	Canals			
5/8/2019 10:12	Canoeing	Canals	Kayaking	Canals	Boat kayak access	Canals	
5/8/2019 10:12	Clean up trash	Everywhere					I stopped going because of the garbage, needles, etc
5/8/2019 10:22							
5/8/2019 10:57							

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5/8/2019 11:07	River side boating put in	Wamesit Falls Overlook area	River side boating take out	Eastern Canal Park			
5/8/2019 11:27							
5/8/2019 12:55	artificial whitewater park	Pawtucket Canal and/or Northern Canal	whitewater rafting and whitewater kayaking				If one hasn't occurred, a city sponsored business study on the economic cost/benefits of constructing an artificial whitewater park would identify the feasibility of such a project. The proximity to such a large population would drastically promote tourism and should be considered within the city's development and economic plan.
5/8/2019 16:01							Entire project needs to be promoted and spruced up. If more activities were offered on a regular basis, more people would enjoy them. Compare attendance and usage with LOWELL WALKS!
5/8/2019 16:20	Shoreline access	Concord River					It's a valuable whitewater resource for kayaking, canoeing and rafting in Eastern Mass
5/8/2019 19:19							
5/8/2019 20:25	better parking	near greenway					
5/9/2019 4:22							
5/9/2019 6:37	Better kayak access		More releases of water		Less trash, especially needles		Yes please improve access flows and cleanliness for whitewater boaters like myself. Many boaters in the Boston area have to drive all the way to mid New Hampshire tonget decent paddling.

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5/9/2019 23:53	Clean up the hypodermic needles	All locations					clean up the hypodermic needles at all locations
5/10/2019 3:58							Used Hypodermic needles are the immediate safety concern that needs to be addressed
5/11/2019 9:55							
5/13/2019 11:14	River clean-up efforts	Concord River	Old dam clean-up/removal	Concord River			Broad boating access around the city of Lowell would result in my using the area for whitewater recreation significantly more frequently. Currently, there's no reasonable access for rafts to the Merrimack River sections with whitewater that I'm generally aware of.
5/16/2019 8:43	Improving flows to the dewatered section of river	Pawtucket falls.	Access trails along river	Along dewatered section of pawtucket falls	Canoe and kayak access point.	Below Pawtucket falls.	Lowell has been over looked and underutilized when it comes to its recreational resource potentials. This facility has lacked any real recreational efforts in its past license. Its current condition, has limited the window of world class whitewater conditions, to a very few days a year. This has limited the amount of participation from the community of enthusiasts of this region. Improving flows, access, pollution from canals and homeless camps along the facility, would greatly improve these conditions. This license is 47 years in that time Lowell could grow into a Richmond VA like city in that timeframe. If the right choices are made for the residents of Lowell and surrounding communities.
5/16/2019 16:15	Improved flow	Pawtucket falls	Gauge to measure flow	Pawtucket falls	Improved access	Pawtucket falls	Large homeless population needs to be addressed. Not saying they need to be evicted but it is need that should be addressed
5/16/2019 20:28	boat trips						

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6/27/2019 12:30	Kayaking	Somewhere safe on canal system	canoeing	Somewhere safe on canal system			More people would like to use the canal system as a form of recreation. Where can this happen? You are the experts to tell us.
6/27/2019 15:24	More trash cans that are emptied frequently	River walk/canal walk	Beautification of the river walk/ canal walk	All			There's sooo much trash in the canals and around the canal walks /river walk. It's really gross.
6/28/2019 19:57	Damage repair/restoration post operations	North canal gate house/gatekeepers house					My comments are not about recreation. They constantly fail to repair damage that is cause from their crane operations at the northern gate house. I have continously tried to establish a working relationship with them, but to no avail. I live in a house via Massachusetts DCR, historic curatorship program, and i promise they continue to fail on the rules of their permit. I deal with these operations on a yearly basis, for almost 5 years. Not once have they followed their permit and repaired damages.
7/4/2019 7:58	Accessibility	Merrill park	Trail maintenance	Merrill Park	Trash removal	Merrill Park	I go to Merrill Park daily. The park does not seem to be maintained at all. There are no amenities. I collect a bag of trash every day on my visit. This park could be a jewel with a little help.
7/4/2019 8:18	Boat launch	Tyngsboro					Boat ramps are crowded on weekends with jet skiers
7/4/2019 8:31	clearing brush and fixing the walking path down to the river bank	toilets					

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7/4/2019 8:50	Trail maintenace	Merrill park	Signage and mapping	Merrill park	Additional ameneties	Merrill park	Riverfront Park needs to be included in the survey area as this is a highly used access point for fishing and paddling and swimming and great for picnics
7/4/2019 9:09	Leave park as is. Donâ€™t encourage use.	Merrill Park					
7/4/2019 9:19	More access to the Northern Canal	Northern Canal					
7/4/2019 9:21							
7/4/2019 9:23	increase access conditions and accessibility to Northern Canal Walkway	Northern Canal Walkway					
7/4/2019 9:28							
7/4/2019 10:37							
7/4/2019 10:38	Protected bicycle lane (or multi-use path parallel to road)	Pawtucket Boulevard - especially, the sidewalk by the Pawtucket Falls Bridge has	Pedestrian signal controls	Crossing by Rourke Bros. Boat Ramp - in the MIDDLE	Protected Bicycle Lane	All bridges across Merrimack River. Yes,	The biggest impediment to cycling in or near the described recreational areas, is safe access by bicycle. The river, itself, is one of the biggest obstacles for cyclists. Within the City of Lowell, only one bridge - at University Ave - is even remotely "bike-friendly", and the intersections at either foot of ALL the bridges are abysmal to cycle through.

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		STAIRS, and is neither bike-friendly, nor even ADA compliant!		section, for access by road cyclists on Pawtucket Boulevard seeking to turn left (to Rourke Bros/ Boat Ramp) or right (to Heritage Ice Cream)		ALL of them!	
7/4/2019 11:20	More accessible walkways / pathways, eliminate stairs	Northern canal walkway					
7/4/2019 11:26							I live in the Boott Mills. The canals have been dry and are dirty and unsightly with litter and trash. Do better
7/4/2019 11:34							
7/4/2019 11:42	bike racks	various					Not every place needs a restroom and a parking lot, it's an urban park and walking should be expected. I'd like to see the Lowell riverwalk connected and extended.

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7/4/2019 12:24	Consider opening some of the canals to recreational boating						So far the river has been consistent in depth since the Crest gate system was installed on the dam.
7/4/2019 12:49							
7/4/2019 12:57							Enel needs to do more to clean up the canals.
7/4/2019 13:10	More Lighting	Riverwalk	More trash removal	All canals	Homeless	All Lowell parks	Let’s tidy up. Let’s raise taxes! Let’s get the community involved!
7/4/2019 13:24	More paths along M river	Hudson	More paths along Nashua River	Nashua, Greeley Park	Safe Road cycling	All, connecting locations	General access to outdoor bike paths & areas to sit in the shade & sun. Connecting bike paths between locations would be good. Availability of coffee and sandwich shops for refreshment would be nice.
7/4/2019 13:53	Improvements	All	Cycling, hiking, fishing, running, walking, swimming	All			
7/4/2019 14:20	More public restrooms	Generally	Signage	Generally			
7/4/2019 15:33	Walkways leveled for better accessibility in certain areas	Canal walks	Canal trash clean up	Merrimack and Eastern canals			Can we have more easily available information about canal draw downs? connect the project area to the rail trails.

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7/4/2019 15:59	Canoe/kayak on the canal	Pawtucket Hamilton canals	Ice skating on canals	Pawtucket	Canal side dining	Pawtucket canal	Need to make the Lowell canals a destination for people to visit. Lighting and activities would be a great start.
7/4/2019 18:01							
7/4/2019 18:36	better and longer parking	Sheehy Memorial	Adult fixed exercise equipment	Merrimack Trail	Dog park	some place other than wher it is	Trash out of the canal. Less flooding in Lowell, due to high river levels. Better water quality in Merrimack.
7/4/2019 22:23							More parks, bocce, bike infrastructure, signage
7/5/2019 7:43	Casual canal boating	Merrimack, Western Canals	Cycling, walking	Merrimack River, Northern Bank	Water Taxi/Drinking/Shopping	Pawtucket Canal	The Canals are difficult for Lowell, as they limit road crossings. But they are also such an amenity unique in Massachusetts. Let's reclaim our title of Venice of America. We could also put up interpretive signage about how the canals still create renewable energy for the area and about how they contribute to the ecology, e.g., fish.
7/5/2019 12:15							
7/5/2019 13:30	Water fountain	All	Public bathroom		Bike and walking trails		The canals always has trash in them
7/5/2019 19:34							
7/7/2019 5:47							
7/7/2019 15:53	Off leash dog park	Anywhere shady by the river					

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7/7/2019 19:13							
7/7/2019 20:43	Boat ramp	Greeley park ramp	Widen access road, more parking fix ramp	Nashua			
7/16/2019 10:45	Better parking (current parking lots aren't enough, VFW highway semi-legal)	Heritage Park	Safety and beautification improvements between Sampas and the School St Bridge, by falls overlook				
7/16/2019 14:05							
7/16/2019 14:30	Seating	Along canal walkways	Parking	Near access points			
7/16/2019 15:09	more lighting						
7/16/2019 16:10	More trees, shade, greenery less pavement	all locations		all locations			

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7/16/2019 18:13	More public restroom access	throughout the area	More native plants to attract birds and mammals	throughout the area			I believe developing this aspect of our city can only make the area more attractive to visitors and better for residents who need access to nature
7/16/2019 18:19	Always concerned with access for non-motorized watercraft.	Through-paddlers					
7/16/2019 18:30							
7/17/2019 8:05	Pedestrian walkway improvement	All	Connecting trails	All	Clear, concise signage for areas and trails	All	Deteriorating sidewalks, excessive weedy brush along all trails. Unacceptable trash accumulation in all waterways detracts from top-notch opportunities for active and passive recreation. Desire paths connecting sites along Merrimack River are not suitable for anyone but the very sure-footed. Trash removal should be regular event not occasional event. More cooperation between private industry and local National Park/City and Conservation partners. The fish ladder is both an eyesore and poor function. Brush and weeds obscure walking vistas. Poison ivy. Chain link fences are not inviting or welcoming. Many walks are not in compliance with ADA regs
7/17/2019 18:53							
7/18/2019 12:07	Bathrooms available year-round	Lowell Heriatge State Park	More parking, less trash in waterWhole	Pawtucket Falls overlook			Whole area is an urban jewel which needs to be preserved and appreciated.

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			area is an urban jewel				
7/18/2019 14:32							
7/19/2019 10:00	better connected walking facilities	from the overlook to the heritage park					collection of trash in the canals and behind the dam.
7/27/2019 21:23	extra dock for boats						at the Rourke Brothers Boat Ramp the dock is only on the left side so most times you have to wait to load or unload. An extra dock on the right side would be very helpful.
7/29/2019 8:15	trash barrels	Rourke Brothers boat ramp					
8/4/2019 9:43	More boat docks	Rourke boat ramp	River hazard removal and or marking	Merrimack river to NH state line			
8/4/2019 14:35	Clean the canals, can't do anything with them being clean	Canals					You can't improve anything if the canals are full of trash.
8/29/2019 20:47	Whitewater boating	Pawtucket Falls	Fishing	Pawtucket Falls	River Surfing	Pawtucket Falls	Improved flow, access and gauging in the dewatered section of Pawtucket Falls, could greatly enhance recreational opportunity, through both whitewater boating and fishing. Creating better shoreline access, will also rid of the unsightly homeless camps, that are in these fenced off areas. Creating much of the water born trash in the dewatered section.

	Question 36-1: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 36-2: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 36-3: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Q37. Please share any other comments that you have regarding recreation near the Lowell Project:
Recorded Date	**Q36-1. Type of Recreation Enhancement:**	**Q. 36-1. Location(s)**	**Q36-2. Type of Recreation Enhancement:**	**Q. 36-2. Location(s)**	**Q36-3. Type of Recreation Enhancement:**	**Q. 36-3. Location(s)**	
8/29/2019 21:06	More fishing access	Canals near tsongas center	Free parking	Suffolk st	Cleaner water	Everywhere	There is a thriving aquatic ecosystem in those canals please help keep it clean for future generations to enjoy.
8/29/2019 21:26	river/bank cleanup and improved access from university ave bridge to beaver brook		trash cleanup at pawtucket falls, parking area, open throughout the year				overall reduction in the amount of trash buildup at dams/canals. Improved access for fishing/sightseeing along the river, especially in the area of umass lowell (university avenue bridge to beaver brook and at pawtucket falls.
8/30/2019 6:03	More shore fishing access from the boat rental ramp past the Rourke Bridge	Rourke Brothers Boat Ramp	Clean up the vegetation as you get closer to the bridge	Rourke Brothers Boat Ramp			
9/3/2019 17:04	None						
9/9/2019 7:24							
9/24/2019 16:02	Boat dock	Greely					The the boat ramp at Greeley is in serious Decline and is a tremendous safety hazard
10/9/2019 13:29							
11/14/2019 18:31	restrooms		interpretive panels		map panels to guide you to other features nearby		opening up the area for walking along the river with lights and benches and trash cans will really make the area, around the college and along the

	Question 36-1: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 36-2: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Question 36-3: Please tell us what type(s) of recreation enhancements you believe are needed and at what specific location(s) at the Lowell Project:		Q37. Please share any other comments that you have regarding recreation near the Lowell Project:
Recorded Date	**Q36-1. Type of Recreation Enhancement:**	**Q. 36-1. Location(s)**	**Q36-2. Type of Recreation Enhancement:**	**Q. 36-2. Location(s)**	**Q36-3. Type of Recreation Enhancement:**	**Q. 36-3. Location(s)**	
							canal, closer to what other cities have successfully done in developing their waterfront areas. great to see this project underway- Lowell is a real gem!
11/15/2019 14:50	Mapiing of navigation hazards	impoundment from Chelmsford to Cromwells Falls					Access in NH is way below contemporary standards
11/26/2019 19:08							
1/20/2020 8:29	Public notification of CSO events	Nashua, Manchester	whitewater recreational releases with improved access and adequate flow information	Pawtucket falls			Public has a right to receive automatic notification of upstream CSO events that would interfere with the use of the Impoundment

Appendix F - Respondents Zip Codes and Representative Map

Personal Interview Respondent Zip Codes

Zip code/location	Miles from Project
01440/Gardner, Massachusetts	42.1
01701/Framingham, Massachusetts	34.3
01810/Andover, Massachusetts	11.6
01821/Billerica, Massachusetts	8.7
01821/Billerica, Massachusetts	8.7
01824/Chelmsford, Massachusetts	6.0
01824/Chelmsford, Massachusetts	6.0
01824/Chelmsford, Massachusetts	6.0
01824/Chelmsford, Massachusetts	6.0
01826/Dracut, Massachusetts	2.4
01826/Dracut, Massachusetts	2.4
01826/Dracut, Massachusetts	2.4
01845/North Andover, Massachusetts	11.9
01850/Lowell, Massachusetts	1.5
01850/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01853/Lowell, Massachusetts	0.5
01853/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5

Zip code/location	Miles from Project
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01863/North Chelmsford, Massachusetts	7.5
01863/North Chelmsford, Massachusetts	7.5
01863/North Chelmsford, Massachusetts	7.5
01863/North Chelmsford, Massachusetts	7.5
01876/Tewksbury, Massachusetts	5.8
01876/Tewksbury, Massachusetts	5.8
01879/Tyngsboro, Massachusetts	11.2
01879/Tyngsboro, Massachusetts	11.2
01886/Graniteville, Massachusetts	12.8
01970/Salem, Massachusetts	33.1
02067/Sharon, Massachusetts	44.4
02461/Newton, Massachusetts	28.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03110/Bedford, New Hampshire	31.3
21009/Abingdon, Maryland	383.0
98040/Mercer Island, Washington	3045.0

Online Survey Zip Codes

Zip Code	Miles from project
01340/Colrain, Massachusetts	88.9
01450/Groton, Massachusetts	19.1
01453/Leominster, Massachusetts	27.9
01463/Pepperell Massachusetts	20.2
01503/Berlin, Massachusetts	26.8
01516/Douglas, Massachusetts	58.9
01604/Worcester, Massachusetts	41.6
01719/Boxborough, Massachusetts	19.5
01748/Hopkinton, Massachusetts	40.0
01757/Milford, Massachusetts	44.5
01760/Natick, Massachusetts	31.8
01821/Billerica, Massachusetts	8.7
01821/Billerica, Massachusetts	8.7
01824/Chelmsford, Massachusetts	6.0
01824/Chelmsford, Massachusetts	6.0
01824/Chelmsford, Massachusetts	6.0
01826/Dracut, Massachusetts	2.4
01826/Dracut, Massachusetts	2.4
01844/Methuen, Massachusetts	9.8
01844/Methuen, Massachusetts	9.8
01850/Lowell, Massachusetts	1.5
01850/Lowell, Massachusetts	1.5
01850/Lowell, Massachusetts	1.5
01850/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5

Zip Code	Miles from project
01851/Lowell, Massachusetts	1.5
01851/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
01852/Lowell, Massachusetts	1.5
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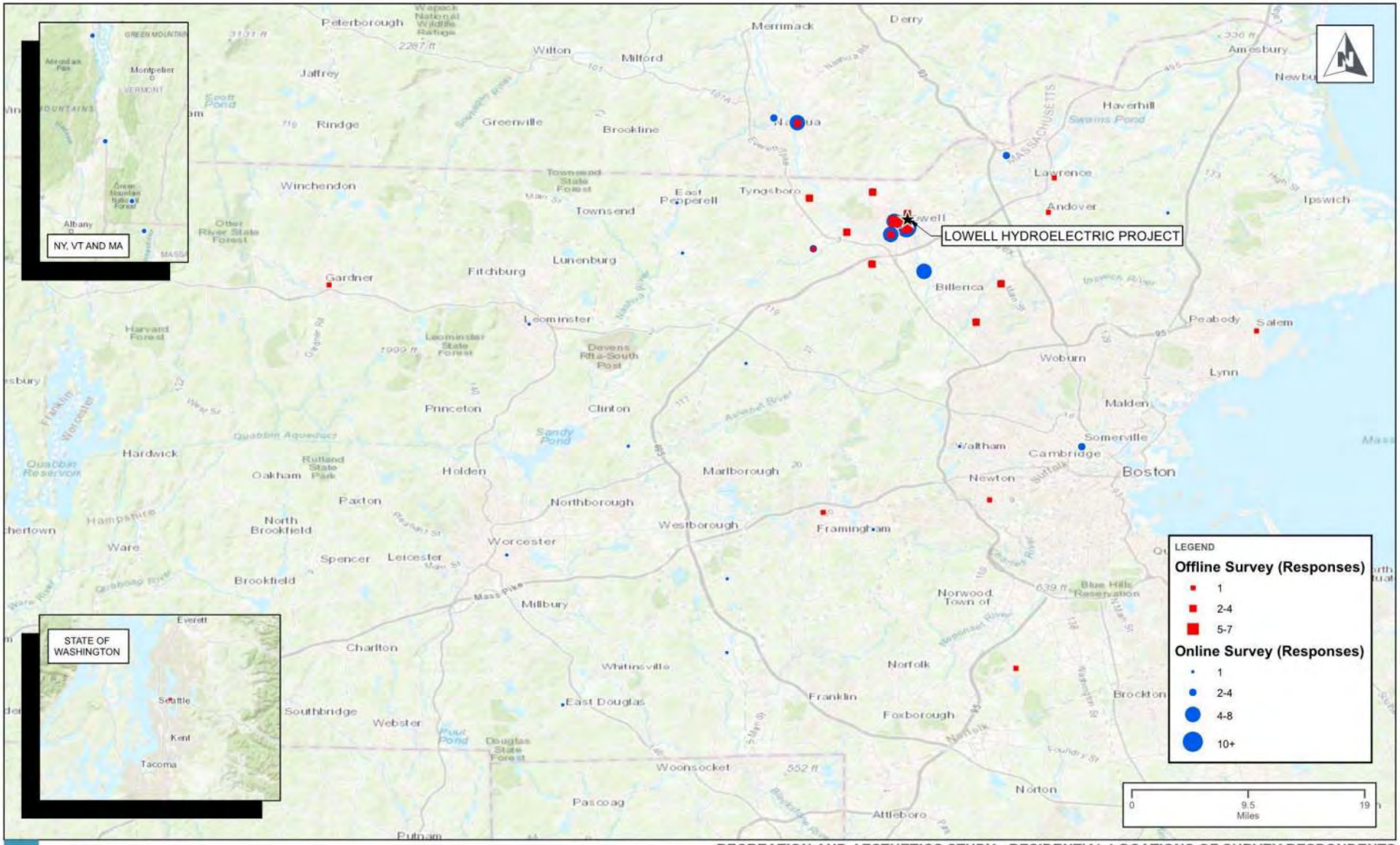
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5

Zip Code	Miles from project
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01854/Lowell, Massachusetts	0.5
01862/North Billerica, Massachusetts	5.1
01862/North Billerica, Massachusetts	5.1
01862/North Billerica, Massachusetts	5.1
01862/North Billerica, Massachusetts	5.1
01862/North Billerica, Massachusetts	5.1
01862/North Billerica, Massachusetts	5.1
01863/North Chelmsford, Massachusetts	7.5
01876/Tewksbury, Massachusetts	5.8
01876/Tewksbury, Massachusetts	5.8
01876/Tewksbury, Massachusetts	5.8
01879/Tyngsboro, Massachusetts	11.2
01886/Westford, Massachusetts	11.2
01886/Westford, Massachusetts	11.2
01921/Boxford, Massachusetts	19.6
02143/Somerville, Massachusetts	26.4
02143/Somerville, Massachusetts	26.4
02451/Waltham, Massachusetts	22.7
3051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5
03051/Hudson, New Hampshire	11.5

Zip Code	Miles from project
03051/Hudson, New Hampshire	11.5
03064/Nashua, New Hampshire	13.0
03064/Nashua, New Hampshire	13.0
03064/Nashua, New Hampshire	13.0
05356/West Dover, Vermont	115.0
05743/Fair Haven, Vermont	175.0
10003/New York City, New York	218.0
12901/Plattsburgh, New York	231.0

*Not all respondents to the online survey provided a home zip code.

Representative Map



BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY - RESIDENTIAL LOCATIONS OF SURVEY RESPONDENTS

LOWELL HYDROELECTRIC PROJECT

FERC NO. 2790

AUGUST 2020

Appendix G - Visual Survey for Vegetation Growth Mapbook

MATCH TO SHEET 02

Legend

- Canal System
- Project Facilities
- Photo Location*

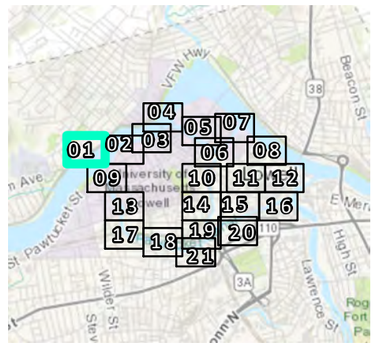
Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

*NOTE: PHOTO LOCATION IS IDENTIFIED IF IT IS NOT ASSOCIATED WITH A DOMINANT VEGETATION POINT OR DOMINANT VEGETATION POLYGON



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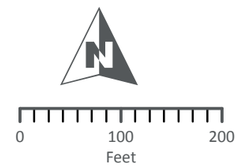

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

MATCH TO SHEET 01

MATCH TO SHEET 03

ORFORD STREET
RIVERSIDE STREET
VARNUM AVENUE
MAMMOTH ROAD
Northern Canal
P - 9
77
78
92
79
80
73
PAWTUCKET GATEHOUSE
P - 6
FANNING STREET
MOUNT WASHINGTON STREET
SCHOOL STREET
PAWTUCKET STREET
ARLINGTON STREET
MOUNT VERNON STREET

Legend

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- Project Facilities
- Photo Location*

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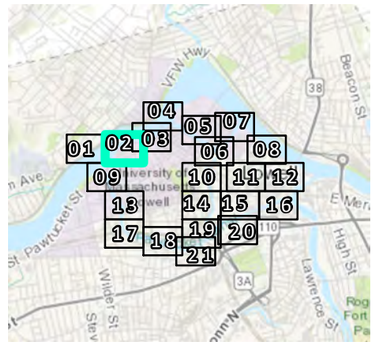

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Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

MATCH TO SHEET 02

P - 8

NORTHERN CANAL GATE HOUSE

P - 10

P - 9

Northern Canal

VETERANS OF FOREIGN WARS HIGHWAY

PLYMOUTH STREET

UNIVERSITY AVENUE

FATHER MORISSETTE BOULEVARD

MERRIMACK STREET

MOODY STREET

PAWTUCKET STREET

FLETCHER STREET

DANE AVENUE

DANE STREET

SALEM STREET

GAGE STREET

WHITING STREET

FANNING STREET

MOUNT WASHINGTON STREET

74 75 76 77 78 92 93

Legend

- Canal System
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- Photo Location*

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Dominant Vegetation Polygon

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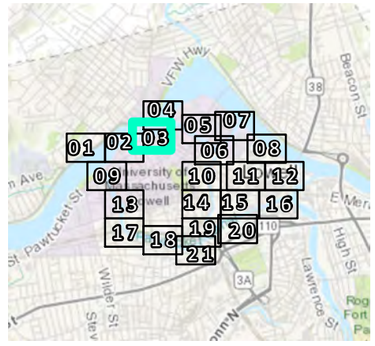

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RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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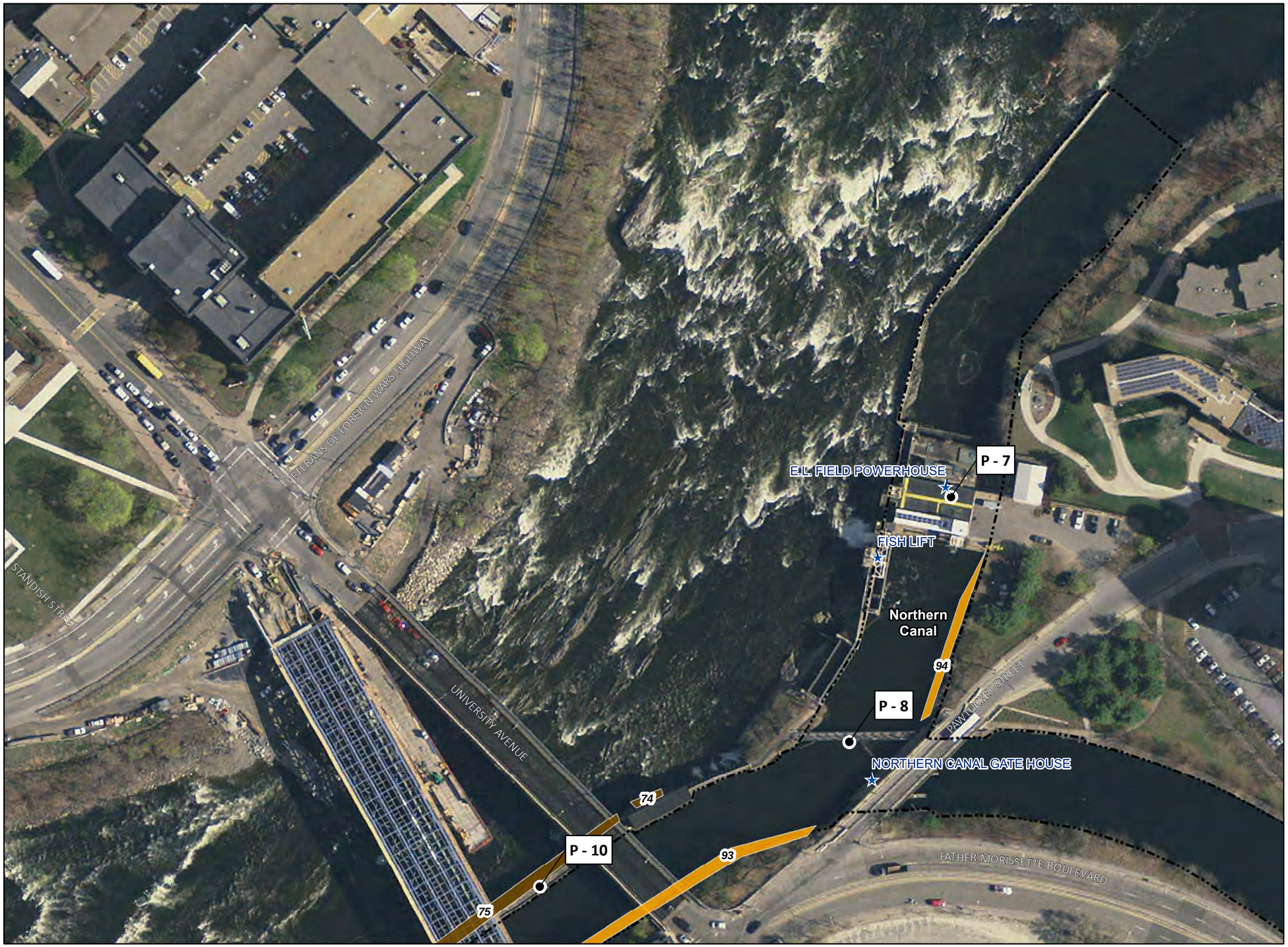

MATCH TO SHEET 05

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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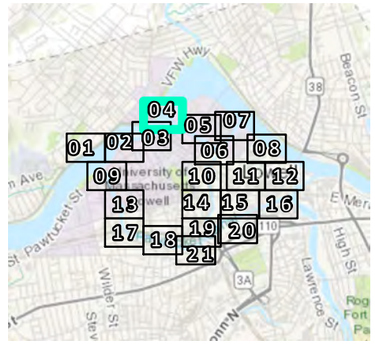

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RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

MATCH TO SHEET 04

MATCH TO SHEET 04

MATCH TO SHEET 07

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

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- Trees

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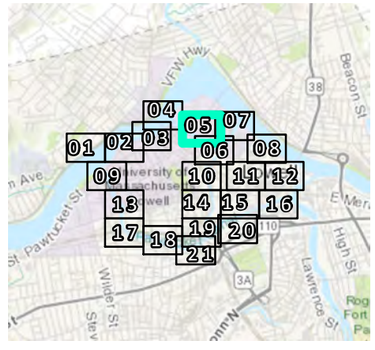

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BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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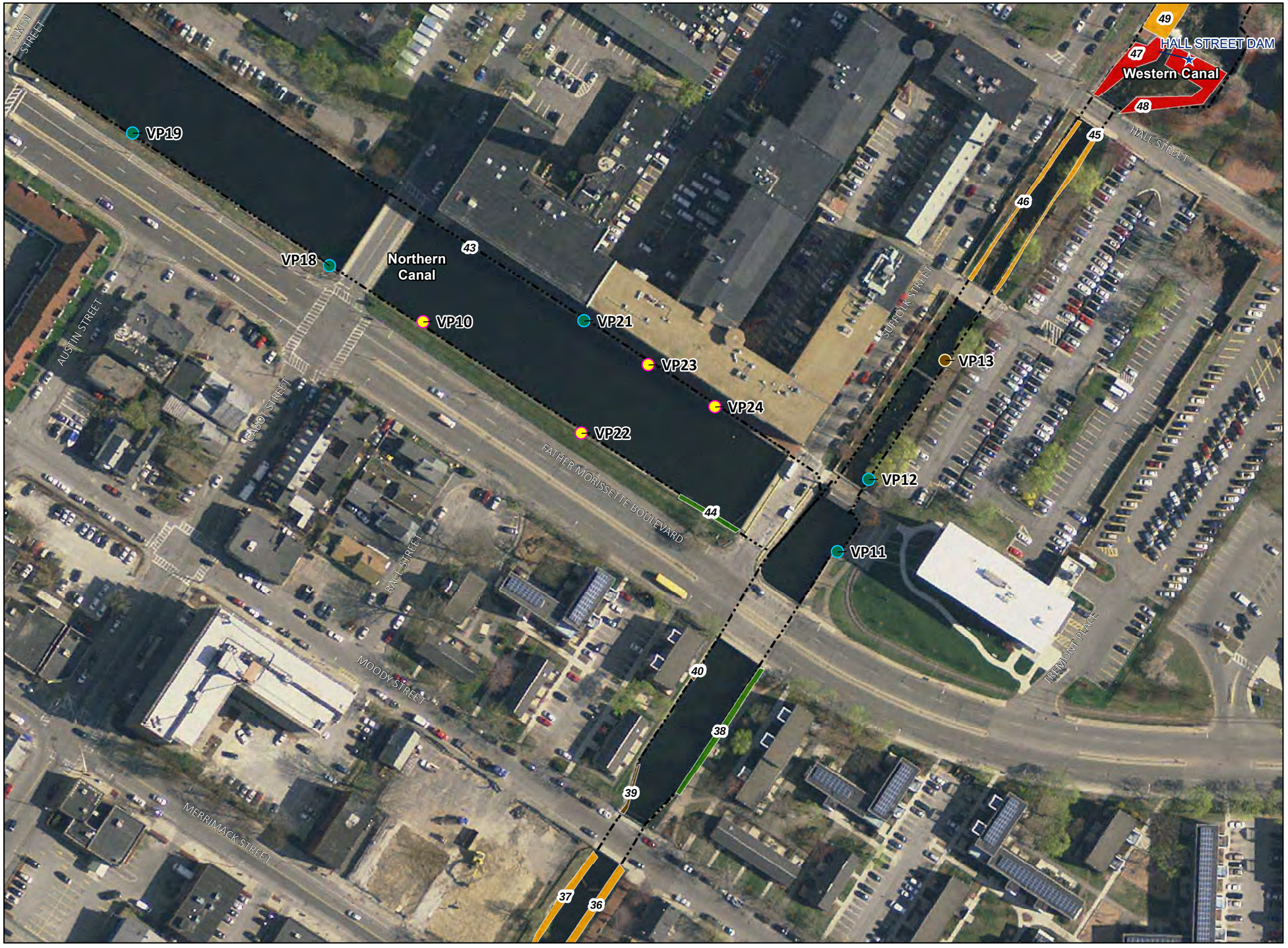
AUGUST 2020



Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

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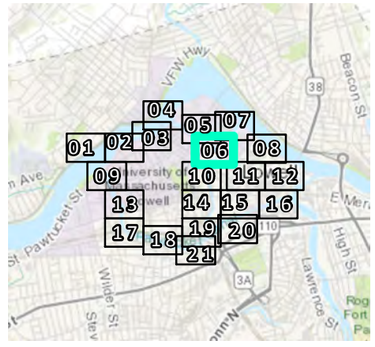

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BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
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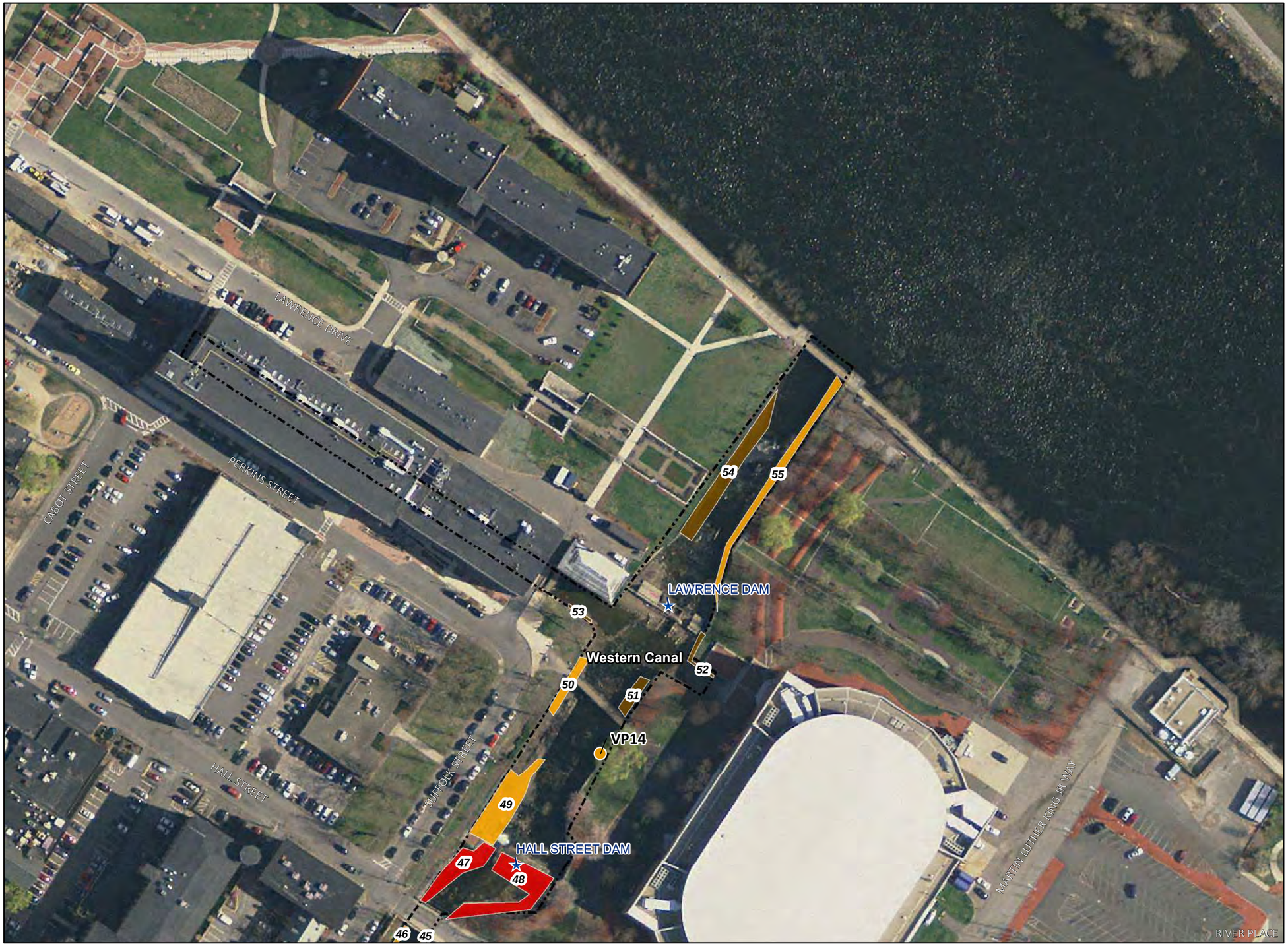
AUGUST 2020

MATCH TO SHEET 05



MATCH TO SHEET 05

Legend

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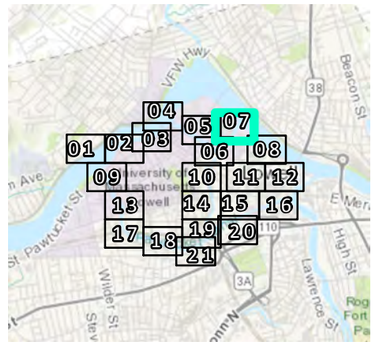

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Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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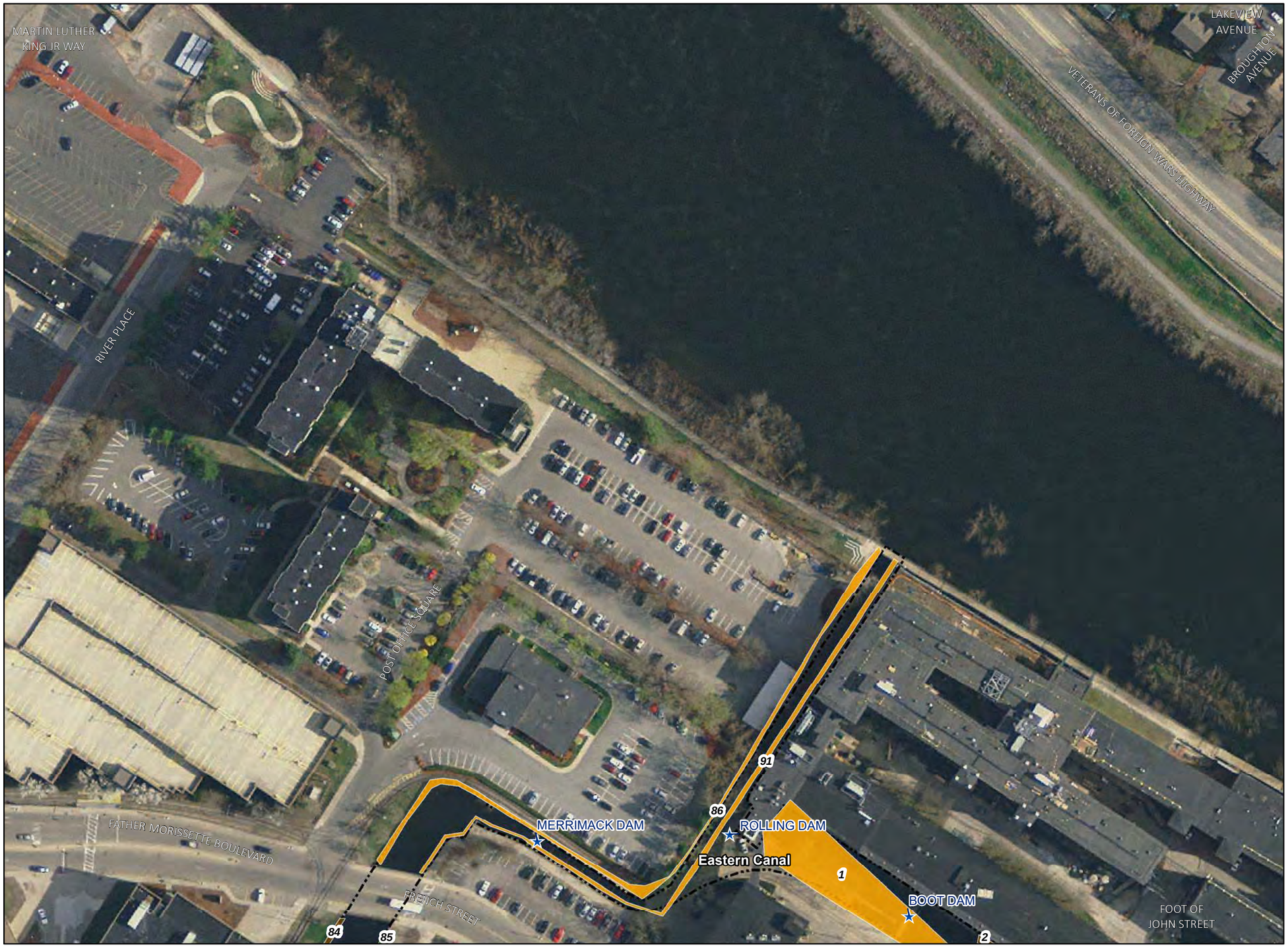
AUGUST 2020

MATCH TO SHEET 07



Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

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- Trees

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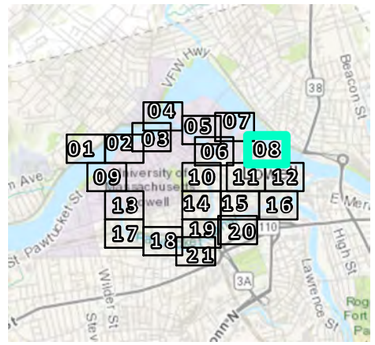

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Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

Legend

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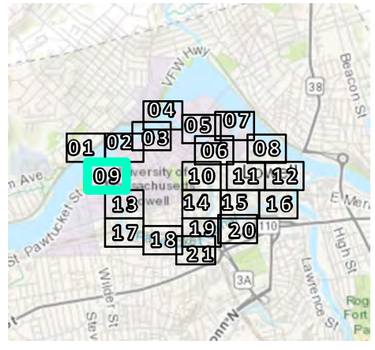

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Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

Legend

- Canal System
- Project Facilities
- Photo Location*

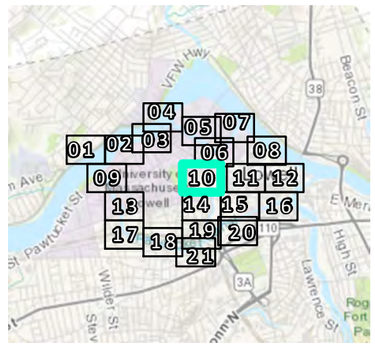
Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

*NOTE: PHOTO LOCATION IS IDENTIFIED IF IT IS NOT ASSOCIATED WITH A DOMINANT VEGETATION POINT OR DOMINANT VEGETATION POLYGON



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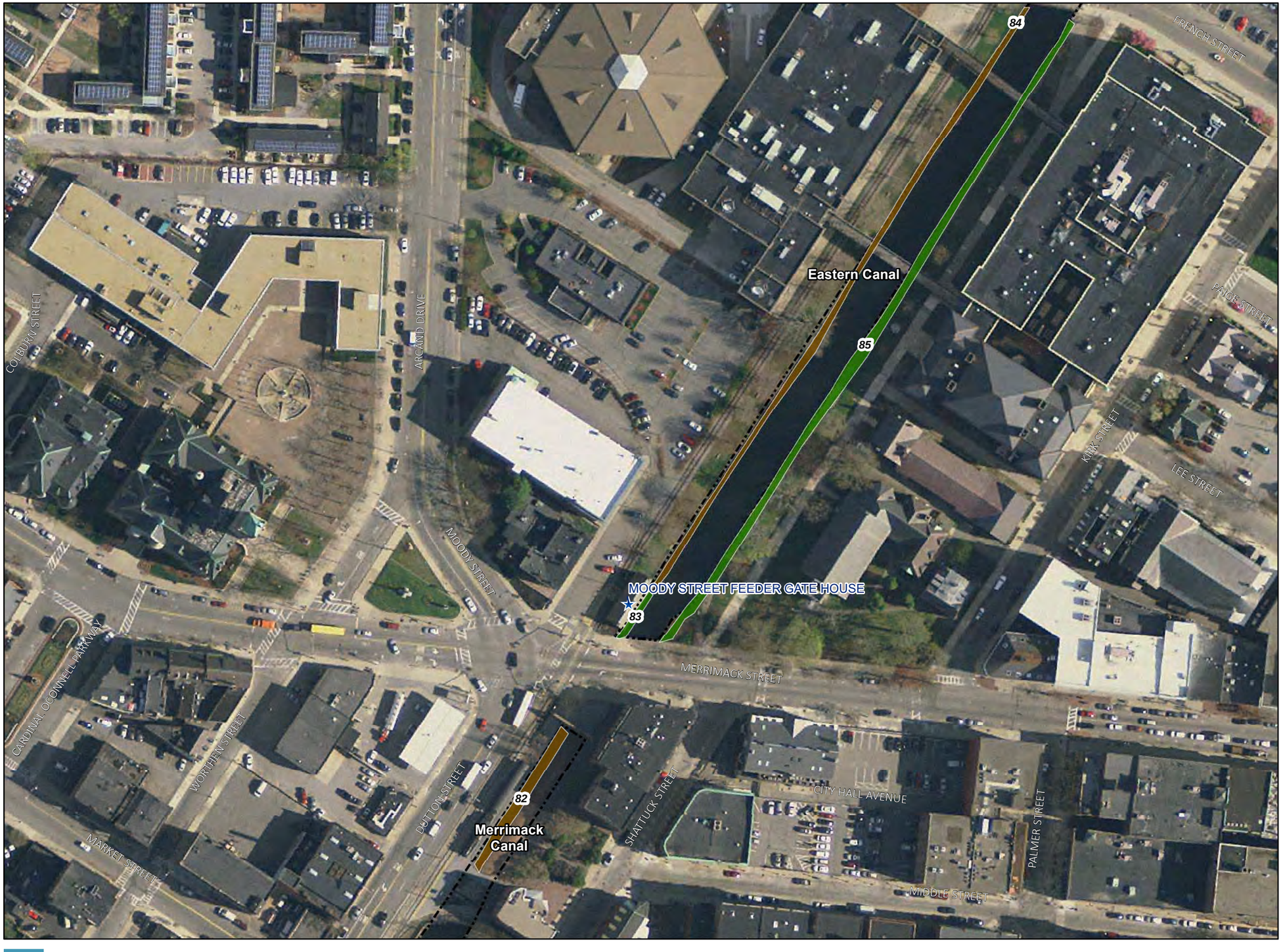
Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020



MATCH TO SHEET 12

Legend

- Canal System
- Project Facilities
- Photo Location*

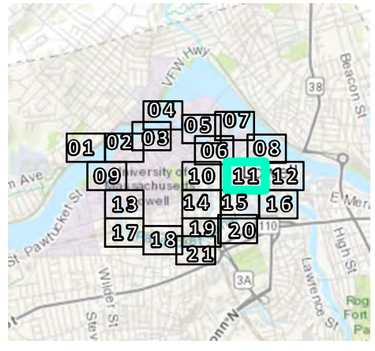
Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

*NOTE: PHOTO LOCATION IS IDENTIFIED IF IT IS NOT ASSOCIATED WITH A DOMINANT VEGETATION POINT OR DOMINANT VEGETATION POLYGON



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BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

MATCH TO SHEET 11

BOOT DAM
1
2
3
VP1
Eastern Canal
87
88
90
89
VP2
4
5
6
KIRK STREET
FOOT OF JOHN STREET
FRENCH STREET
BROOKINGS STREET
AMORY STREET
BRIDGE STREET
MASSACHUSETTS MILLS DRIVE
JOHN STREET
LEE STREET
PAIGE STREET
CANAL STREET
MERRIMACK STREET
CENTRAL STREET
PRESCOTT STREET
KEARNEY SQUARE

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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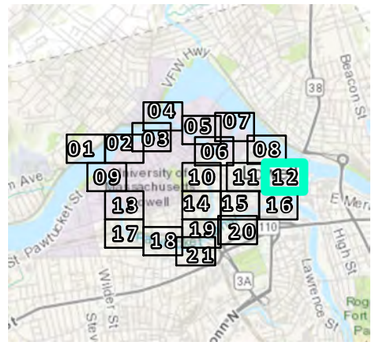

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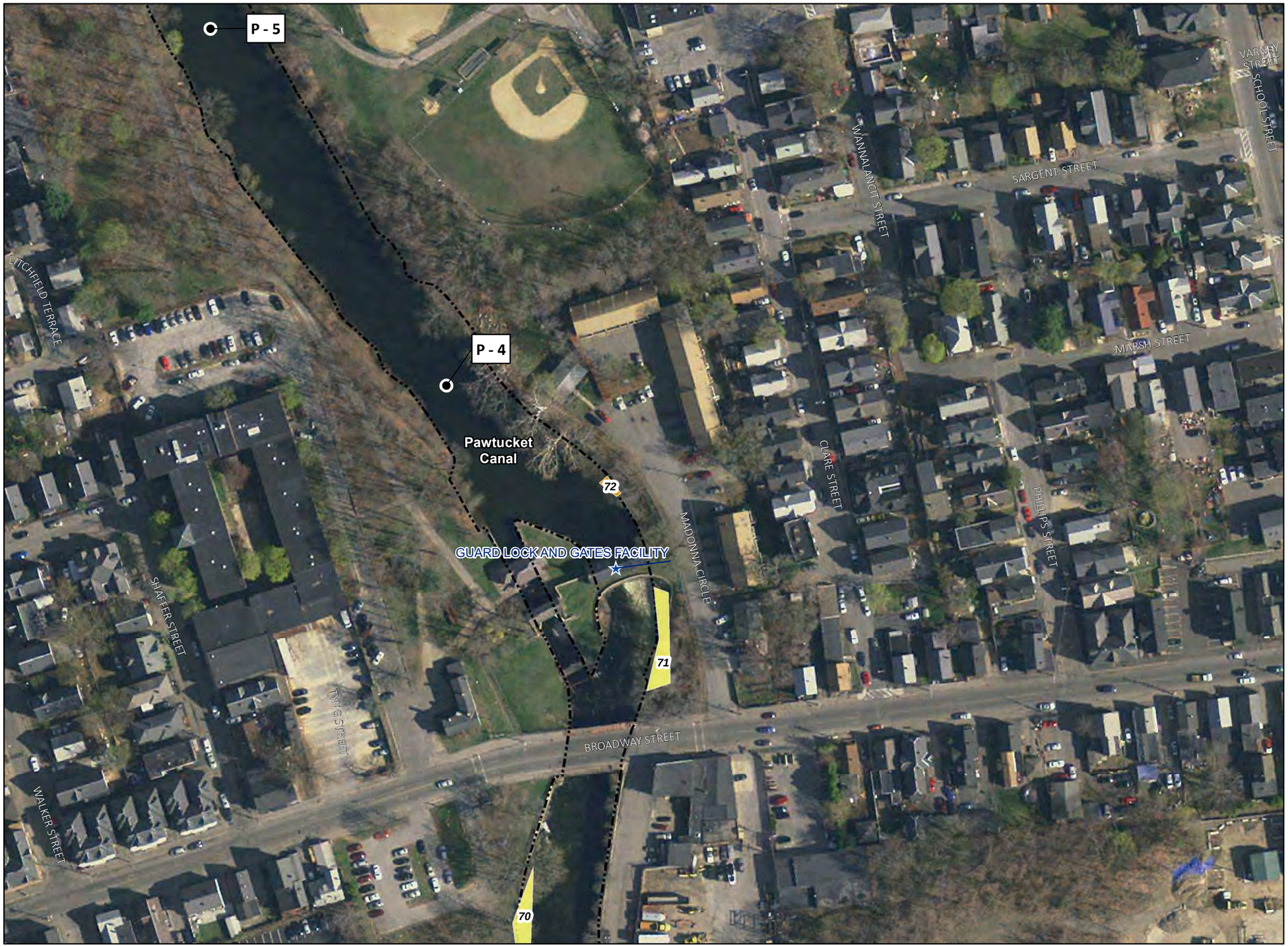

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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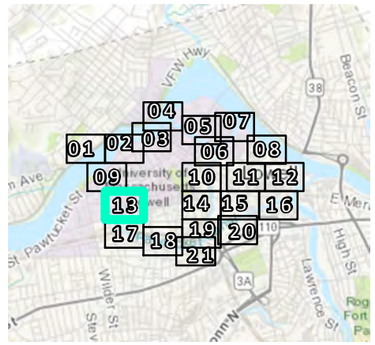

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Feet

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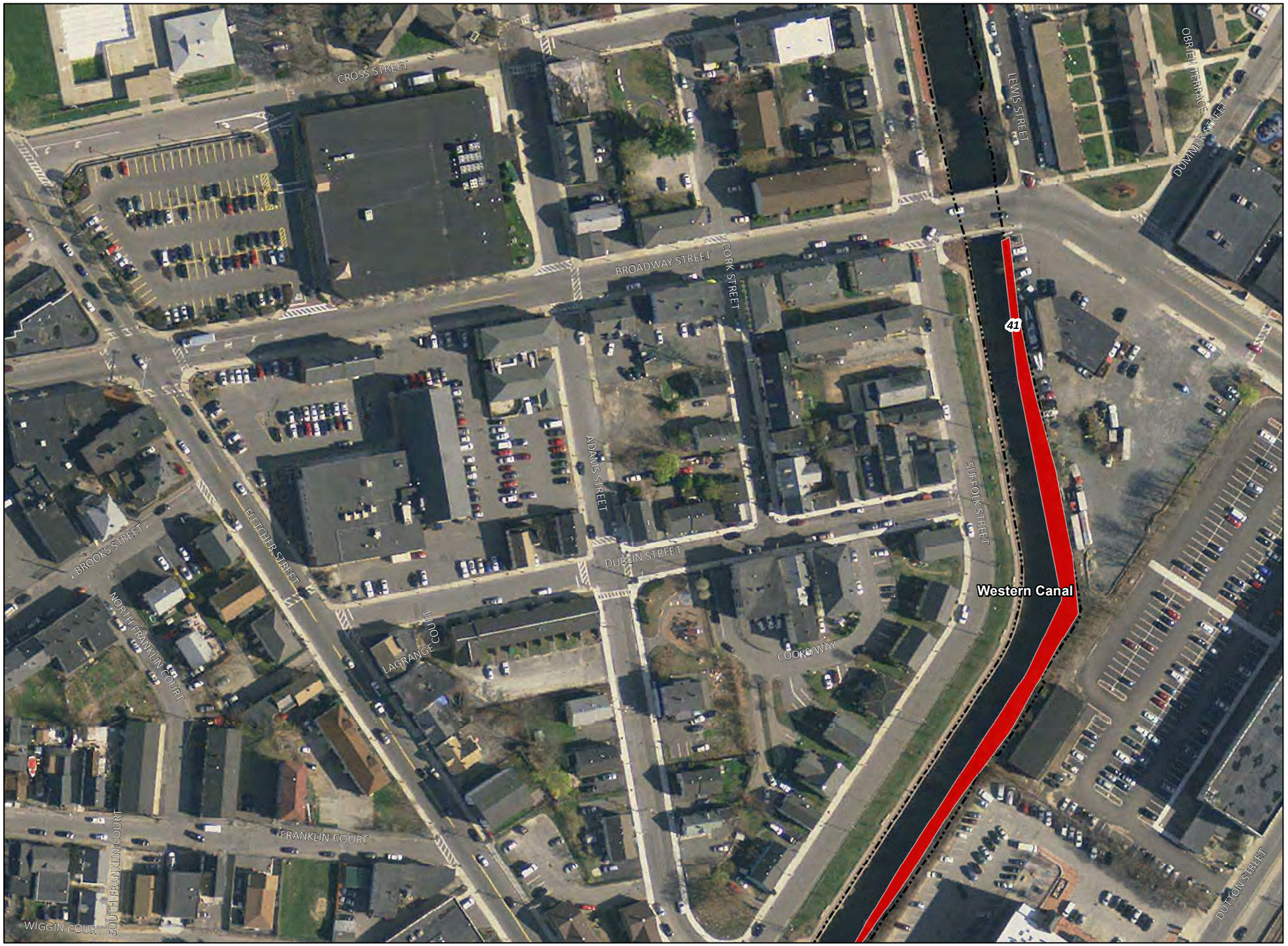
PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020



MATCH TO SHEET 15

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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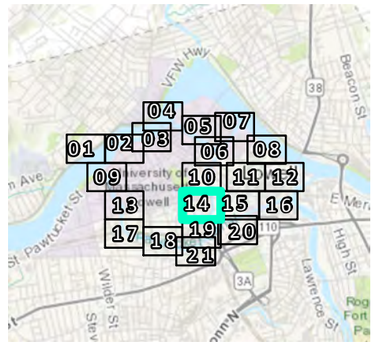

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Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

MATCH TO SHEET 14

MATCH TO SHEET 16

DUMMER STREET
WORTHEN STREET
DUTTON STREET
BROADWAY STREET
SHATTUCK STREET
MARKET STREET
PALMER STREET
Merrimack Canal
Pawtucket Canal
Pawtucket Canal
Hamilton Canal
MERRIMACK GATE
81
12
13
15
16
14
17
18
32
31
33

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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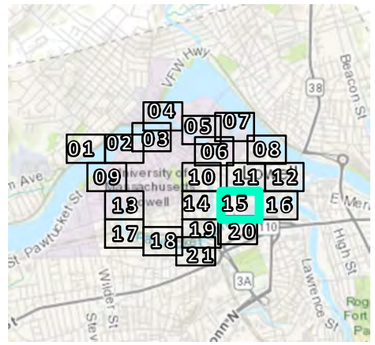

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0 100 200
Feet

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LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

MATCH TO SHEET 15

MIDDLE STREET
PRESCOTT STREET
KEARNEY SQUARE
EAST MERRIMACK STREET
MARKET STREET
CENTRAL STREET
WARREN STREET
HURD STREET
JACKSON STREET
GEORGE STREET
WILLIAMS STREET

Eastern Canal
Pawtucket Canal
Hamilton Canal

VP3
VP4
VP5
VP6
VP7
LOWER LOCKS AND DAM
P - 1

6
7
8
9
10
11

Legend

- Canal System
- Project Facilities
- Photo Location*

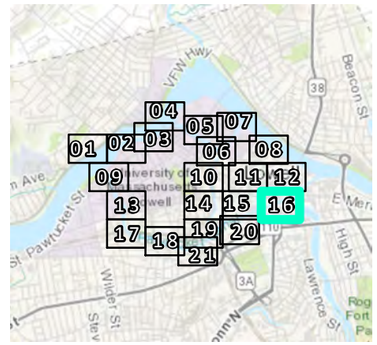
Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

*NOTE: PHOTO LOCATION IS IDENTIFIED IF IT IS NOT ASSOCIATED WITH A DOMINANT VEGETATION POINT OR DOMINANT VEGETATION POLYGON



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0 100 200
Feet

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RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
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PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

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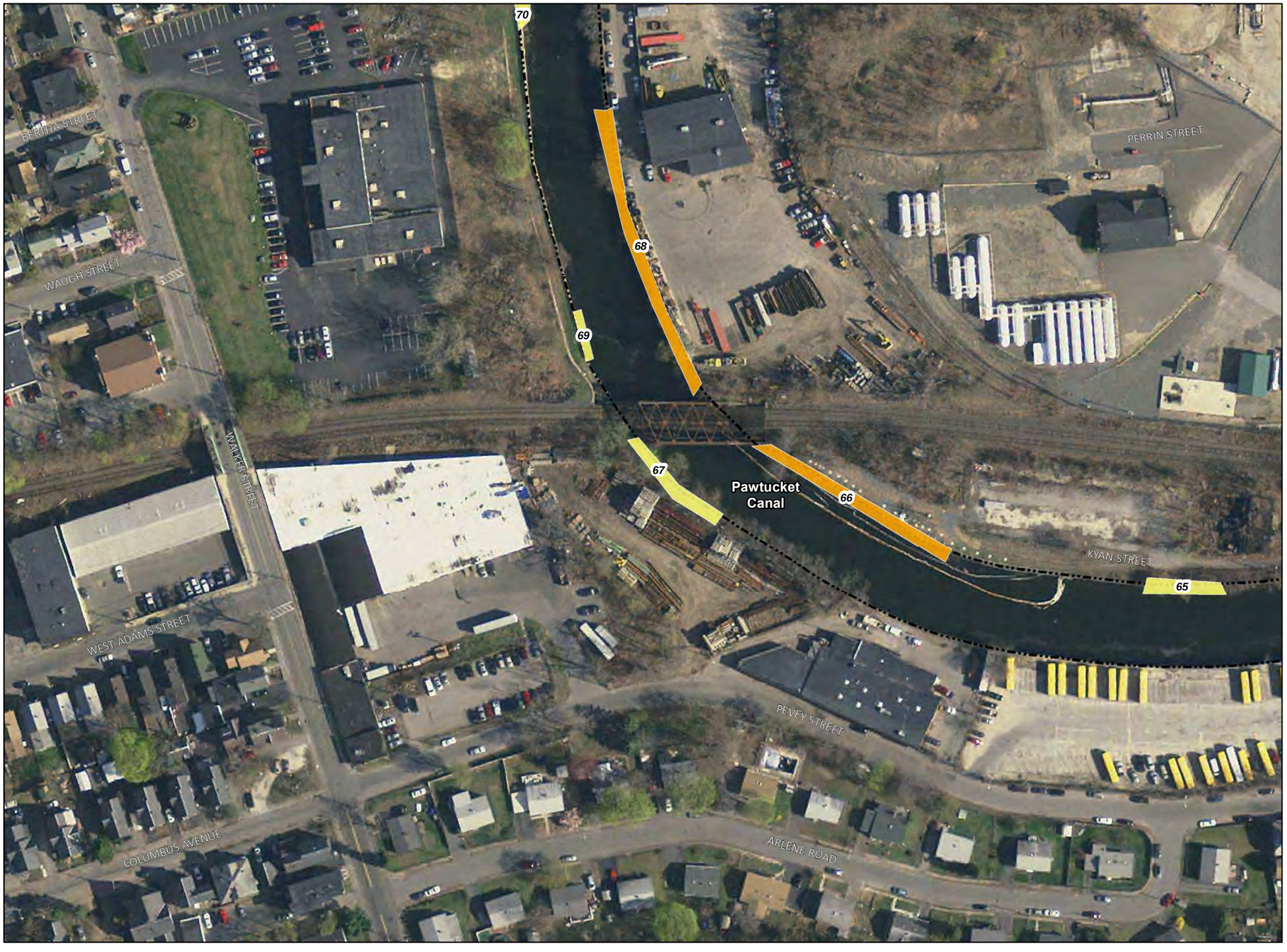


MATCH TO SHEET 18

Legend

- Canal System
- Project Facilities
- Photo Location*

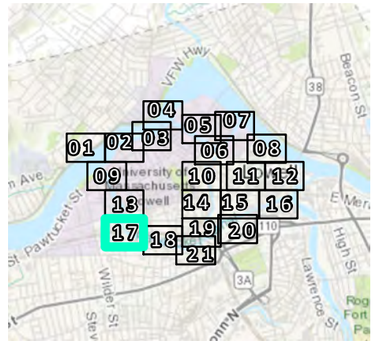
Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

*NOTE: PHOTO LOCATION IS IDENTIFIED IF IT IS NOT ASSOCIATED WITH A DOMINANT VEGETATION POINT OR DOMINANT VEGETATION POLYGON



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Feet

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LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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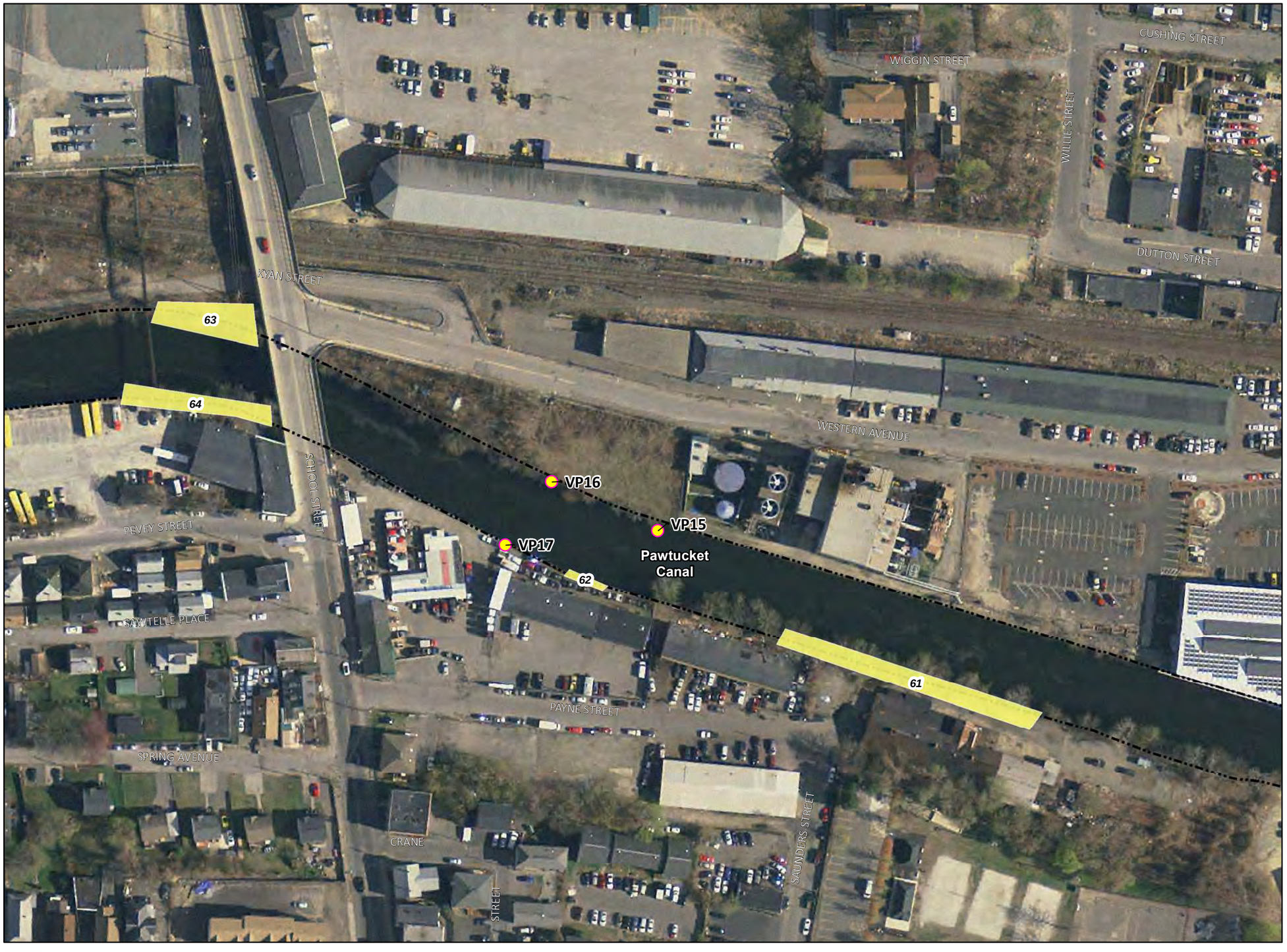
AUGUST 2020

MATCH TO SHEET 17



MATCH TO SHEET 21

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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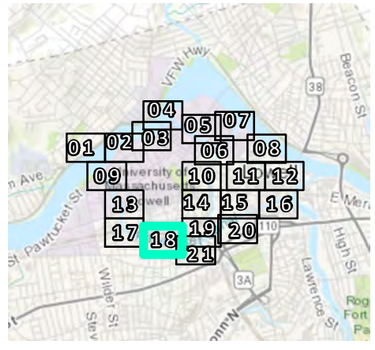

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Feet

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RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

MATCH TO SHEET 18

MATCH TO SHEET 20

SOUTH FRANKLIN COURT
WIGGIN COURT
ROCK STREET
ADAMS STREET
SUFFOLK STREET
FLETCHER STREET
NORTHEAST STREET
CUSHING STREET
WAMESIT COURT
DUTTON STREET
DUTTON AVENUE
WESTERN AVENUE
THORNDIKE STREET
MIDDLESEX STREET
RAMP-MIDDLESEX ST/LORD OVERPASS TO DUTTON ST NB

Western Canal
Hamilton Canal
Pawtucket Canal

41
42
18
19
20
20a
23
22
22a
21
56
57

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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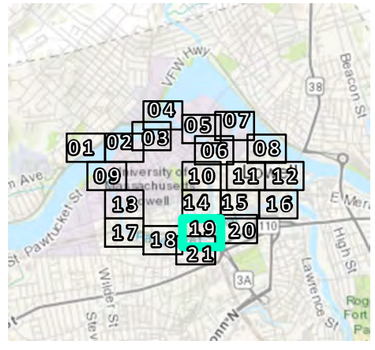

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LOWELL HYDROELECTRIC PROJECT
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AUGUST 2020

MATCH TO SHEET 19

Merrimack Canal

DUTTON STREET

MERRIMACK GATE

VP9

33

31

Pawtucket Canal

SWAMP LOCKS AND DAM

30

29

18

19

27

26

JACKSON STREET

MARSTON STREET

ELLIOT STREET

23

25

Hamilton Canal

22

22a

VP8

24

ROBESON STREET

REVERE STREET

MIDDLESEX STREET

SPRING STREET

SOUTH STREET

PEARL STREET

GARNET STREET

APPLETON STREET

APPLETON PLACE

WINTER STREET

WEST JACKSON STREET

KING STREET

RAMP-MIDDLESEX ST/LORD OVERPASS TO DUTTON ST NB

GOWARD PLACE

MATCH TO SHEET 19

Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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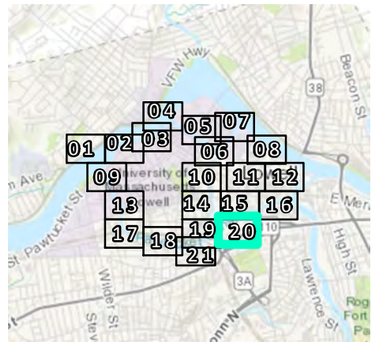

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0 100 200
Feet

BOOTT HYDRO, LLC.

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LOWELL HYDROELECTRIC PROJECT
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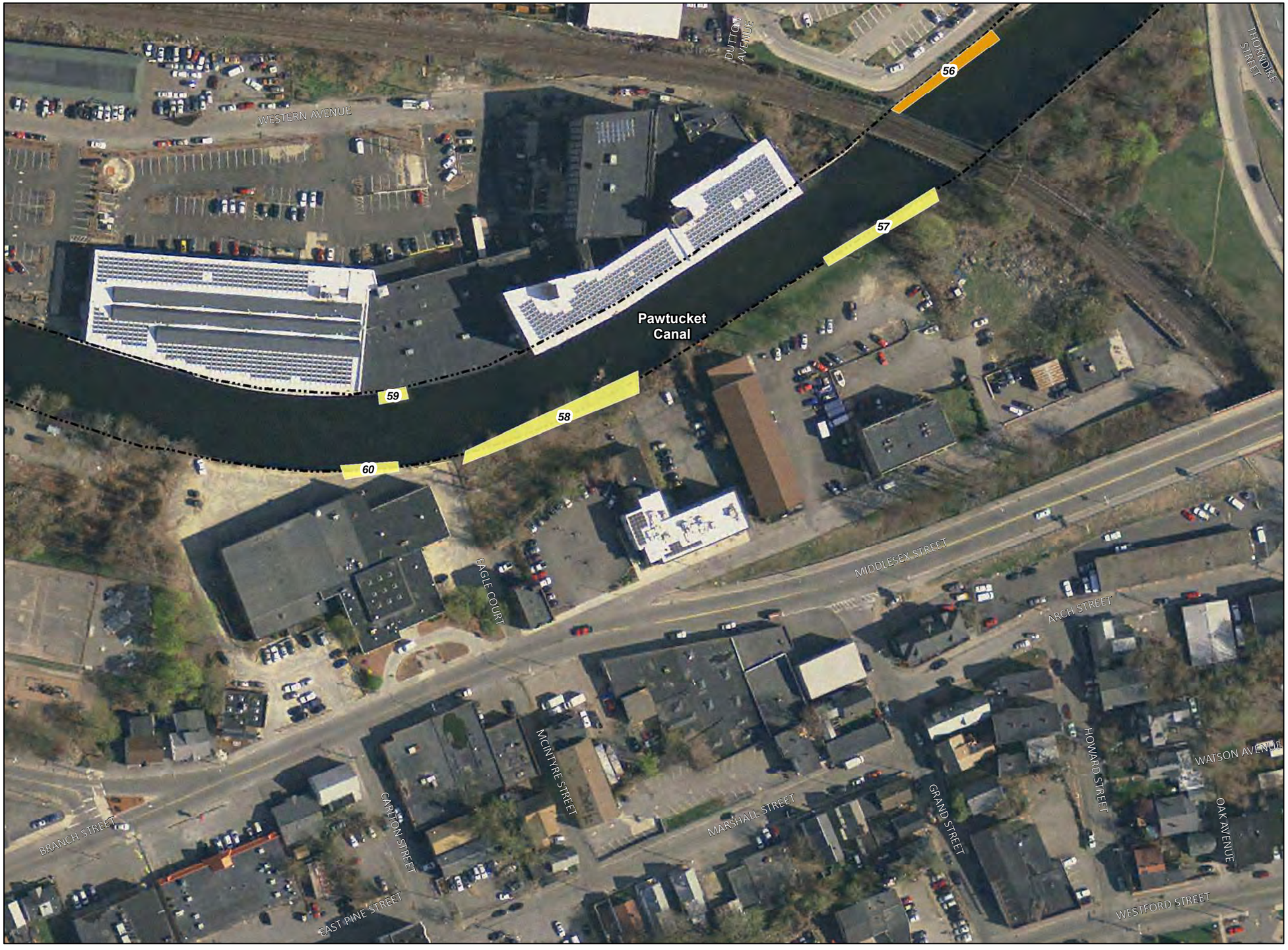
PATH: \\SYR-SRV01\GIS\PROJECTS\ENEL\LOWELL_RELICENSE\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_VEGETATION_COVERTYPESTUDY11X17_0304.MXD - USER: KAUSTIN - DATE: 8/18/2020

AUGUST 2020

MATCH TO SHEET 18



Legend

- Canal System
- Project Facilities
- Photo Location*

Dominant Vegetation Point

- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

Dominant Vegetation Polygon

- Forested
- Herbaceous
- Mixed
- Scrub-Shrub
- Trees

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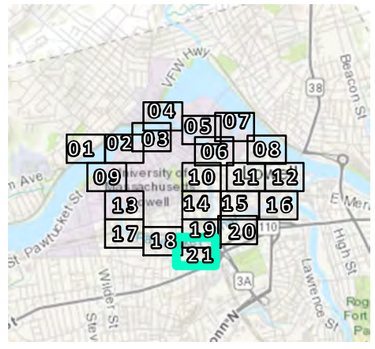

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0 100 200
Feet

BOOTT HYDRO, LLC.

RECREATION AND AESTHETICS STUDY
LOWELL HYDROELECTRIC PROJECT
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AUGUST 2020

Appendix H - Visual Survey for Vegetation Growth Data

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
1[4]	Mixed	Block Wall	Eastern	12	0.337	4.026	8.371	Several large woody trees are located at the northwestern end of the canal, while herbaceous plants dominate the western side of the canal
2	Herbaceous	Block Wall	Eastern	12	0.015	4.026	0.373	Small black locust scattered among purple loosestrife and other herbaceous weeds at base of building
3[4]	Mixed	Block Wall	Eastern	12	0.002	4.026	0.050	One elm tree, Boston ivy, ragweed; bottom of canal contains scattered aquatic vegetation
4[4]	Trees	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.002	4.026	0.050	One multi-trunked tree of heaven, 4 to 6 inches DBH
5	Trees	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.001	4.026	0.025	One multi-trunked birch, 1 inch DBH
6	Trees	Block Wall	Eastern	12, 16	0.024	4.026	0.596	Multiple tree of heaven and elm trees rooted and growing between stones of canal wall
7	Trees	Stone Wall	Pawtucket	16	0.034	19.630	0.173	Several large woody trees including river birch, tree of heaven, and silver maple, all 2 to 5 inches DBH
8	Herbaceous	Block Wall	Pawtucket	16	0.013	19.630	0.066	Canal contains what appears to be sediment deposited against the canal wall, sediment is topped with a layer of herbaceous plants
9	Trees	Concrete	Pawtucket	16	0.003	19.630	0.015	One tree of heaven and one unidentified hardwood growing on top of canal wall
10	Scrub-Shrub	Block Wall/Concrete/Stone Wall Mix	Pawtucket	16	0.010	19.630	0.051	Four tree of heaven, all 1 inch DBH growing on/out of canal wall
11	Scrub-Shrub	Block Wall	Pawtucket	16	0.003	19.630	0.015	Multiple tree of heaven growing out of canal wall
12	Trees	Block Wall/Concrete/Stone Wall Mix	Merrimack	15	0.002	1.402	0.143	Three multi-trunked elm trees, all with 1 inch DBH growing out of canal wall
13	Trees	Concrete	Merrimack	15	0.003	1.402	0.214	One elm tree and one mulberry growing out of concrete portion of canal wall
14	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Merrimack	15	0.054	1.402	3.852	Approximately 20% of the canal wall has woody trees (i.e. elms, locust, and mulberry) or herbaceous plants growing on it

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
15	Scrub-Shrub	Block Wall/Concrete/Stone Wall Mix	Merrimack	15	0.054	1.402	3.852	Approximately 20% of the canal wall has woody trees or herbaceous plants growing on it; woody trees include elms, locust, and mulberry
16	Herbaceous	Block Wall	Merrimack	15	0.053	1.402	3.780	Approximately 20% of the canal wall has woody trees (i.e. elms, locust, and mulberry) or herbaceous plants growing on it
17	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Merrimack	15	0.049	1.402	3.495	Approximately 20% of the canal wall has woody trees (i.e. mulberry and tree of heaven) or herbaceous plants growing on it
18	Mixed	Block Wall	Pawtucket	15, 19, 20	0.121	19.630	0.616	Tree of heaven, ragweed, maple, common mullein, Japanese knotweed, estimated at 20 % cover; Japanese knotweed density increased at NPS boat dock
18a*	Mixed	Block Wall	Merrimack	15, 19, 20	0.121	1.402	8.631	Approximately 20% of the canal wall has woody trees, shrubs, and/or herbaceous plants growing on it; vegetation includes tree of heaven, maple, common mullein, Japanese knot weed and ragweed. Japanese knot weed coverage increases with closer proximity to the NPS boat dock
19	Scrub-Shrub	Block Wall	Pawtucket	19, 20	0.037	19.630	0.188	Vegetation on canal wall includes elms, birches, and scattered ferns
20	Trees	Block Wall	Pawtucket	19	0.023	19.630	0.117	Catalpa tree is growing out of the top of the canal wall and several tree of heaven and birch, some with 5 to 10 inches DBH
20a*	Trees	Block Wall	Pawtucket	19	0.005	19.630	0.025	Catalpa growing out of wall, several trees of heaven, and birch, some with DBH of 5 to 10 inches
21	Scrub-Shrub	Block Wall/Concrete/Stone Wall Mix	Pawtucket	19	0.020	19.630	0.102	Vegetation on canal wall includes glossy buckthorn, boxelder, and tree of heaven, some with 3 to 5 inches DBH
22	Mixed	Block Wall/Concrete/Stone Wall Mix	Hamilton	19, 20	0.076	2.005	3.791	Vegetation on canal wall includes woody trees such as tree of heaven and elms, scattered herbaceous plants such as ragweed and mullein, and Virginia creeper vine
22a*	Mixed	Block Wall/Concrete/Stone Wall Mix	Pawtucket	19, 20	0.010	19.630	0.051	Tree of heaven, elms, ragweed, mullein, and Virginia creeper

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
23[4]	Scrub-Shrub	Block Wall	Hamilton	19, 20	0.027	2.005	1.347	Vegetation on canal wall is primarily tree of heaven and ragweed, with lesser density of mullein
24	Trees	Block Wall/Concrete/Stone Wall Mix	Hamilton	20	0.010	2.005	0.499	Vegetation on canal wall is primarily box elder and ragweed, with sporadic coverage of elm trees
25[4]	Trees	Block Wall	Hamilton	20	0.032	2.005	1.596	Vegetation growing out of canal wall includes one sycamore, several tree of heaven, glossy buckhorn, and ragweed
26[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Hamilton	20	0.105	2.005	5.237	The canal wall, west of walking bridge, consists of portions of concrete and is primarily covered in ragweed. The canal wall, east of walking bridge, contains trees, such as tree of heaven and elm
27[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Hamilton	20	0.076	2.005	3.791	Vegetation on canal wall consists primarily of trees with approximately 10 percent cover. Trees are smaller and less dense on canal wall east of the walking bridge. The canal wall west of the walking bridge consists of portions of concrete
29[5]	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Hamilton	20	0.024	2.005	1.197	Vegetation growing out of canal wall at the eastern end is hard to distinguish because of lack of access; however, vegetation coverage was approximately 15-20 percent and likely consists of ragweed, ivy, and elms
30	Mixed	Block Wall/Concrete/Stone Wall Mix	Pawtucket	20	0.013	19.630	0.066	Vegetation is located at the toe of the canal wall and includes elm, tree of heaven, ragweed, and jewelweed
31	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Pawtucket	15, 20	0.019	19.630	0.097	Vegetation growing out of canal wall is primarily herbaceous species, including purple loosestrife, Japanese knotweed, jewelweed, and buckthorn shrubs
32	Scrub-Shrub	Block Wall	Pawtucket	15	0.046	19.630	0.234	Shrubs are growing along the top of the canal wall, but cannot distinguish species because of lack of access; cannot tell if shrubs are growing out of the canal wall
33	Mixed	Block Wall	Pawtucket	15, 20	0.111	19.630	0.565	Vegetation growing on top of canal wall include several tree species and herbaceous species

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
34[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Western	10	0.014	5.510	0.254	Vegetation growing on the canal wall is sparse and consists primarily of vines. Vegetation growing on top of and approximately 3 feet back from canal wall is primarily herbaceous
35[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Western	10	0.014	5.510	0.254	Vegetation growing out of the canal wall is sparse and there are a few trees growing on top of and approximately 3 feet back from the canal wall
36[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Western	6, 10	0.036	5.510	0.653	Vegetation growing out of canal wall consists of mostly vines with a few tree of heaven are growing on top of and approximately 5 feet back from canal wall
37	Mixed	Block Wall/Concrete/Stone Wall Mix	Western	6, 10	0.034	5.510	0.617	Vegetation growing out of canal wall consists of mostly vines and a few tree of heaven are growing on top of and approximately 3 feet back from canal wall
38[4]	Scrub-Shrub	Block Wall	Western	6	0.025	5.510	0.454	Vegetation growing out of the canal wall, near the top, consists of shrubs,
39[4]	Herbaceous	Block Wall	Western	6	0.004	5.510	0.073	A few, small tree of heaven trees are growing out of the canal wall, near the top of wall
40	Herbaceous	Block Wall	Western	6	0.002	5.510	0.036	Small clump of shrubs growing out of the canal wall
41[4]	Forested	Block Wall/Concrete/Stone Wall Mix	Western	14, 19	0.377	5.510	6.842	Portions of the canal wall at bridge crossings on each side of the canal are concrete and brick; the highest density of vegetation in the polygon consists of locust, tree of heaven, box elder, maples and scattered shrubs, some with 6 to 14 inches DBH
42	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Western	19	0.051	5.510	0.926	Vegetation on canal wall consists of scattered herbaceous species that include Japanese knotweed, and scattered shrubs
43	Scrub-Shrub	Block Wall	Northern	6	0.001	11.670	0.009	Small clump of maple and elms growing on the canal wall
44	Scrub-Shrub	Block Wall	Northern	6	0.009	11.670	0.077	A clump of five small trees, including ash and elm with 1 to 2 inches DBH, growing on the canal wall

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
45[4]	Mixed	Block Wall	Western	6, 7	0.019	5.510	0.345	Vegetation growing on the eastern side of the canal wall includes several trees (i.e. mulberry, buckthorn, tree of heaven) and dense vines, including Boston and poison ivy
46[4]	Mixed	Block Wall	Western	6, 7	0.020	5.510	0.363	Vegetation growing on western side of the canal wall includes less trees than the eastern side of the canal wall (see Polygon 46) and similar vine species, such as Boston ivy and poison ivy
47[4]	Forested	Block Wall/Concrete/Stone Wall Mix	Western	6, 7	0.037	5.510	0.672	Vegetation growing on the canal wall includes large locust trees and ragweed
48	Forested	Block Wall/Concrete/Stone Wall Mix	Western	6, 7	0.065	5.510	1.180	Vegetation growing on the canal wall includes dense clumps of large buckhorn, elm, and birch
49	Mixed	Block Wall/Concrete/Stone Wall Mix	Western	6, 7	0.060	5.510	1.089	Tree of heaven, elms, vines and dense herbaceous species growing on canal wall
50	Mixed	Block Wall	Western	7	0.015	5.510	0.272	Tree of heaven, elms, and ragweed growing on canal wall
51[4]	Herbaceous	Block Wall	Western	7	0.012	5.510	0.218	Vegetation growing on canal wall include trees, such as mulberry and elms, and herbaceous ragweed
52	Herbaceous	Block Wall	Western	7	0.006	5.510	0.109	Vegetation growing on canal wall include trees, such as sycamore, and herbaceous species, such as purple loosestrife and Japanese knotweed
53	Herbaceous	Block Wall	Western	7	0.002	5.510	0.036	Small shrubs are growing out of canal wall
54[4]	Herbaceous	Block Wall	Western	7	0.060	5.510	1.089	Vegetation growing on canal wall consists primarily of vines; a few tree of heaven trees are growing at the toe of the canal wall, likely on deposited sediment
55[4]	Mixed	Block Wall	Western	7	0.045	5.510	0.817	Vegetation growing on canal wall consists primarily of herbaceous vegetation, such as ragweed, and vines; a few tree of heaven also growing on canal wall, but mostly at the toe of the canal wall

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
56[4]	Mixed	Concrete	Pawtucket	19, 21	0.037	19.630	0.188	Most of the canal wall is made of concrete with riprap placed at the toe of the wall; vegetation growing on wall consists of tree of heaven, box elder, and vines, such as Boston ivy
57	Trees	Block Wall	Pawtucket	19, 21	0.043	19.630	0.219	Vegetation growing out of the canal wall includes ash trees with 6 to 8 inches DBH
58[4]	Trees	Block Wall	Pawtucket	21	0.086	19.630	0.438	Vegetation growing out of the canal wall includes locust trees, tree of heaven, wild grape, and oriental bittersweet
59	Trees	Block Wall/Concrete/Stone Wall Mix	Pawtucket	21	0.010	19.630	0.051	Clump of trees currently growing out of the canal wall was being removed at time of survey
60	Trees	Block Wall	Pawtucket	21	0.019	19.630	0.097	Vegetation growing out of canal wall includes five small shrubs and ash and elm trees
61	Trees	Block Wall	Pawtucket	18	0.144	19.630	0.734	Vegetation growing out of canal wall consists primarily of oriental bittersweet; trees, such as birch and box elder, are growing primarily on top of the canal wall at the edge
62	Trees	Block Wall	Pawtucket	18	0.008	19.630	0.041	4 small birches are growing out of the canal wall
63	Trees	Block Wall	Pawtucket	18	0.091	19.630	0.464	Several tree species are growing out of the canal wall
64	Trees	Block Wall	Pawtucket	18	0.078	19.630	0.397	Black locust and box elder with 2 to 4 inches DBH are growing out of canal wall
65	Trees	Block Wall	Pawtucket	17	0.033	19.630	0.168	Tree species growing out of canal wall include tree of heaven, locust, and birch
66[4]	Mixed	Block Wall	Pawtucket	17	0.078	19.630	0.397	Vegetation growing out of canal wall at top of the wall include trees such as tree of heaven and birch, and vines, such as Boston ivy
67[4]	Trees	Block Wall	Pawtucket	17	0.044	19.630	0.224	Large locust and birch trees growing on top of canal wall
68	Mixed	Block Wall	Pawtucket	17	0.103	19.630	0.525	Sporadic trees, including elms and birch, and ragweed are growing on top edge of canal wall; vines, such as Boston ivy growing down canal wall

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
69[4]	Trees	Block Wall/Concrete/Stone Wall Mix	Pawtucket	17	0.012	19.630	0.061	Trees growing out of canal wall include tree of heaven and elms, approximately 10 feet tall
70[4]	Trees	Concrete	Pawtucket	13, 17	0.033	19.630	0.168	Canal wall is primarily concrete with trees, such as locust and elm, growing at the toe of the wall
71	Trees	Block Wall	Pawtucket	13	0.039	19.630	0.199	Tree of heaven and elm trees are primarily growing on top of the canal wall
72	Mixed	Block Wall	Pawtucket	13	0.005	19.630	0.025	Vegetation growing out of canal wall includes tree of heaven and vines
73	Scrub-Shrub	Block Wall	Northern	2	0.056	11.670	0.480	Tree of heaven, catalpa, and ash trees are growing on top of the canal wall
74[4]	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Northern	3,4	0.007	11.670	0.060	Ragweed is growing out of the canal wall located beneath the building
75[4]	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Northern	3,4	0.236	11.670	2.022	Vegetation is growing from small sill under the first block down on the canal wall and is dominated by herbaceous plants, such as ragweed, purple loosestrife, aster, scattered ferns, golden rod spp., scattered mulberry, elms, and buckthorn.
76	Mixed	Block Wall	Northern	3	0.157	11.670	1.345	Scattered trees and shrubs are growing out of the canal wall and along the toe of the wall
77[4]	Forested	Block Wall/Concrete/Stone Wall Mix	Northern	2, 3	0.048	11.670	0.411	At the western edge of polygon, the canal broadens and is forested with riparian species; topography extends to bypass reach; species include elms, mulberry, and honeysuckle; some stumps have been cut along the wall on the same side as the bypass reach
78[4]	Herbaceous	Block Wall	Northern	2, 3	0.011	11.670	0.094	Vegetation growing out of the canal walls include tree of heaven and mulberry and herbaceous species such as purple loosestrife and mullein
79[4]	Scrub-Shrub	Block Wall	Northern	2	0.017	11.670	0.146	Tree of heaven trees and vines are growing on top of the canal wall and within approximately 3 feet of the canal wall
80	Trees	Block Wall	Northern	2	0.033	11.670	0.283	Vegetation consists of few, large trees growing at the toe of the canal wall

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
81	Herbaceous	Stone Wall	Merrimack	15	0.003	1.402	0.214	Scattered ferns and 1 small, 4 ft. maple with .5 inch DBH growing out of canal wall
82[4]	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Merrimack	11	0.045	1.402	3.210	90% vegetative cover in this area; vegetation is mostly herbaceous, including ragweed, clover, *Aster* spp., and weeds; two small tree of heaven also present on canal wall
83	Scrub-Shrub	Block Wall	Eastern	11	0.010	4.026	0.248	Vegetation on the canal wall includes a dense clump of climbing vines, one small maple, and one small honeysuckle
84[4]	Herbaceous	Block Wall	Eastern	8, 11	0.109	4.026	2.707	Approximately 20% vegetative cover on the western side of the canal wall located primarily one block down from the top of the wall; vegetation includes a few maples, honeysuckle, and scattered herbaceous species.
85[4]	Scrub-Shrub	Block Wall	Eastern	8, 11	0.160	4.026	3.974	Approximately 40% vegetative cover on the east side of the canal wall; vegetation includes several 5 ft. elms, several birches, and a few red maples
86[4]	Mixed	Block Wall	Eastern	8	0.088	4.026	2.186	Mixed vegetation includes tree of heaven and some emergent wetland vegetation and cattail spp.; other herbaceous species are growing at the bottom of the canal
87	Mixed	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.014	4.026	0.348	Vegetation growing out of the canal wall includes and 8-trunked box elder at 5-10 inches DBH, glossy buckthorn, and two mulberry shrubs
88	Mixed	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.012	4.026	0.298	Vegetation growing out of the canal wall includes five tree of heaven at 1-2 inches DBH, one quaking aspen, and several multi-stemmed birches
89[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.046	4.026	1.143	Vegetation growing out of the canal wall includes an approximately 10-trunked tree of heaven tree at 6 inches DBH and poison ivy
90[4]	Trees	Block Wall/Concrete/Stone Wall Mix	Eastern	12	0.034	4.026	0.845	Vegetation growing out of canal wall is a 3-trunked tree of heaven tree at 4 inches DBH; also observed a recently cut birch tree tied with rope

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
91[4]	Mixed	Block Wall/Concrete/Stone Wall Mix	Eastern	8	0.078	4.026	1.937	Vegetation growing on the canal wall is primarily herbaceous, however, one maple at approximately 5-10 inches DBH is within polygon
92[4]	Forested	Block Wall	Northern	2, 3	0.191	11.670	1.637	View toward south side of canal showing vegetation growing on top of single stone/block
93[4]	Mixed	Earthen/ Terrestrial Cultural	Northern	3,4	0.093	11.670	0.797	View looking toward E.L Field Powerhouse, vegetation growing on bedrock along the south side of the canal
94	Mixed	Earthen/ Terrestrial Cultural	Northern	4	0.034	11.670	0.291	View looking west toward the E.L. Field Powerhouse from the NPS walking trail; vegetation is growing on bedrock along the south side of the canal
VP-1[4]	Scrub-Shrub	Block Wall	Eastern	12	N/A	4.026	N/A	Vegetation includes a single shrub growing out of the canal wall below the brick building and sparse herbaceous species
VP-2	Scrub-Shrub	Block Wall/Concrete/Stone Wall Mix	Eastern	12	N/A	4.026	N/A	Two tree of heaven at 1 inch DBH are growing out of the canal wall
VP-3	Scrub-Shrub	Block Wall/Concrete/Stone Wall Mix	Eastern	16	N/A	4.026	N/A	A single maple tree and a single elm tree are growing out of the canal wall
VP-4[4]	Scrub-Shrub	Stone Wall	Pawtucket	16	N/A	19.630	N/A	A multi-trunked clump of trees, approximately 6 to 8 feet tall, are growing out of canal wall
VP-5	Trees	Stone Wall	Pawtucket	16	N/A	19.630	N/A	A single small hardwood tree, approximately 6 feet tall, is growing out of the canal wall at toe of wall
VP-6	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Pawtucket	16	N/A	19.630	N/A	A single, small elm, approximately 4 feet tall, is growing out of canal wall/piping along wall
VP-7	Trees	Block Wall/Concrete/Stone Wall Mix	Pawtucket	16	N/A	19.630	N/A	One birch at 3 inches DBH is growing out of the canal wall
VP-8	Herbaceous	Block Wall/Concrete/Stone Wall Mix	Hamilton	20	N/A	2.005	N/A	One tree of heaven, approximately 4 feet tall, is growing at the edge of the lock platform

Vegetation Polygon/ Point Identifier	Dominant Vegetation Type[1]	Dominant Shoreline Type[2]	Canal[3]	Mapbook Sheet(s)	Polygon Acreage	Canal Acreage	% of Polygon	Field Notes Summary/Comments
VP-9	Scrub-Shrub	Concrete	Pawtucket	20	N/A	19.630	N/A	One tree of heaven growing out of a concrete portion of the canal wall, at top of the wall along sidewalk
VP-10[4]	Trees	Block Wall	Northern	6	N/A	11.670	N/A	Small maple growing out of the canal wall, near top of wall
VP-11[4]	Scrub-Shrub	Block Wall	Western	6	N/A	5.510	N/A	A small clump of silver maples are growing out of canal wall
VP-12	Scrub-Shrub	Concrete	Western	6	N/A	5.510	N/A	A small clump of mulberry growing out of canal wall
VP-13[4]	Herbaceous	Block Wall	Western	6	N/A	5.510	N/A	One tree of heaven growing out of canal wall
VP-14[4]	Mixed	Block Wall	Western	7	N/A	5.510	N/A	A small clump of shrubs growing out of canal wall
VP-15	Trees	Block Wall	Pawtucket	18	N/A	19.630	N/A	A single ash tree growing out of the canal wall
VP-16[4]	Trees	Block Wall	Pawtucket	18	N/A	19.630	N/A	Large tree growing out of canal wall
VP-17	Trees	Block Wall	Pawtucket	18	N/A	19.630	N/A	Small tree growing out of canal wall near outfall
VP-18	Scrub-Shrub	Block Wall	Northern	6	N/A	11.670	N/A	Two small shrubs growing on top of the canal wall
VP-19	Scrub-Shrub	Block Wall	Northern	5,6	N/A	11.670	N/A	One tree, likely dead, growing out of canal wall
VP-20	Scrub-Shrub	Block Wall	Northern	5	N/A	11.670	N/A	A single shrub (next to smaller shrubs) growing out of the canal wall
VP-21	Scrub-Shrub	Block Wall	Northern	6	N/A	11.670	N/A	Tree of heaven and oriental bittersweet growing out canal wall
VP-22	Trees	Block Wall	Northern	6	N/A	11.670	N/A	One small maple growing out of the canal wall
VP-23	Trees	Block Wall	Northern	6	N/A	11.670	N/A	Small clump of birch trees growing out of canal wall
VP-24	Trees	Block Wall	Northern	6	N/A	11.670	N/A	One small birch tree growing out of canal wall

Notes:

***** In instances where a polygon was recorded in more than one canal, for reporting purposes, it was separated into two distinct polygons that were each given a unique polygon identifier (e.g., 18 and 18a).

N/A = Not Applicable. Vegetation Points (VPs) were used to identify areas along canal walls where a single vegetation type point was recorded. VPs were not included in vegetation category percentage calculations because they represent a single point on the canal wall and were not assigned area estimates**.**

[1] Dominant Vegetation Types:
Herbaceous - Characterized by primarily herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants less than 3 feet tall.
Scrub-Shrub - Consists of woody plants less than 3 inches diameter at breast height (DBH) and greater than or equal to 3 feet tall.
Trees - Consists of woody plants 3 inches or more in DBH, regardless of height. This vegetation type description was generally used to describe areas along canal walls where only a few trees were growing in a clump.
Forested - Characterized as a relatively large area that consists of primarily trees and underbrush.
Mixed - Characterized by a mosaic of herbaceous, scrub-shrub, and/or trees.

[2] Dominant Shoreline Types:
Block Wall - Canal walls primarily dominated by placed, generally uniformly-sized blocks with concrete caps or block alone.
Concrete - Canal walls primarily dominated by concrete, with various types of cements and aggregate.
Earthen/Terrestrial Cultural - Canal walls generally dominated by earthen embankments (forested and unforested) and areas of exposed bedrock. Some of these areas (e.g., riprapped areas) have been created and/or maintained by human activities.
Stone Wall - Canal walls primarily dominated by placed, generally non-uniformly-sized blocks with concrete caps or blocks alone.
Block Wall/Concrete/Stone Wall Mix - Areas of canal walls predominantly composed of a conglomeration of block wall, concrete, or stone wall at varying quantities.

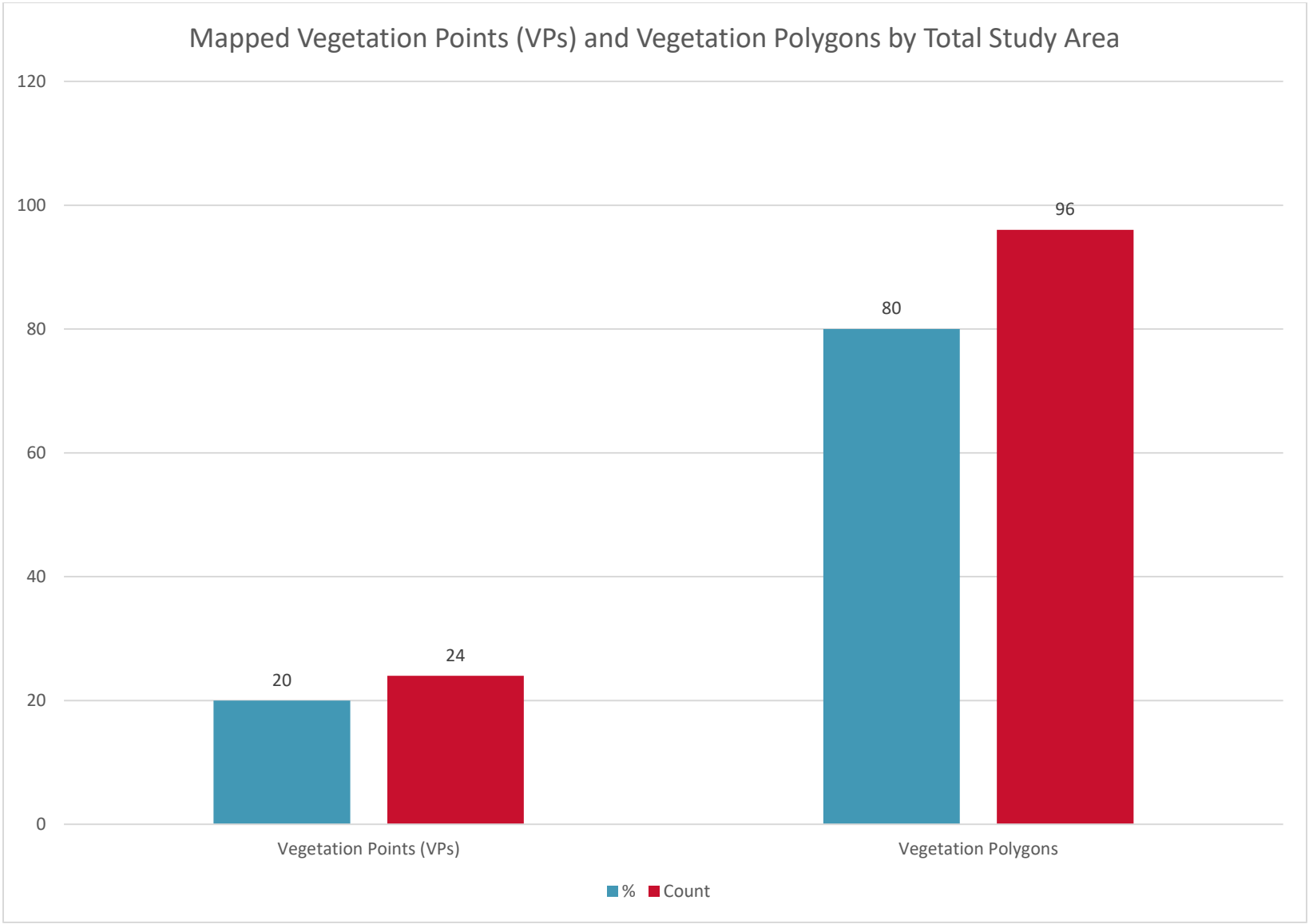
[3] The vegetation survey was conducted between September 25 and 27, 2019. For the purposes of examining vegetation type distribution, the study area was divided into the six canals associated with the Lowell Project canal system including: 1) Pawtucket Canal; 2) Northern Canal; 3) Western Canal; 4) Merrimack Canal; 5) Eastern Canal; and 6) Hamilton Canal.

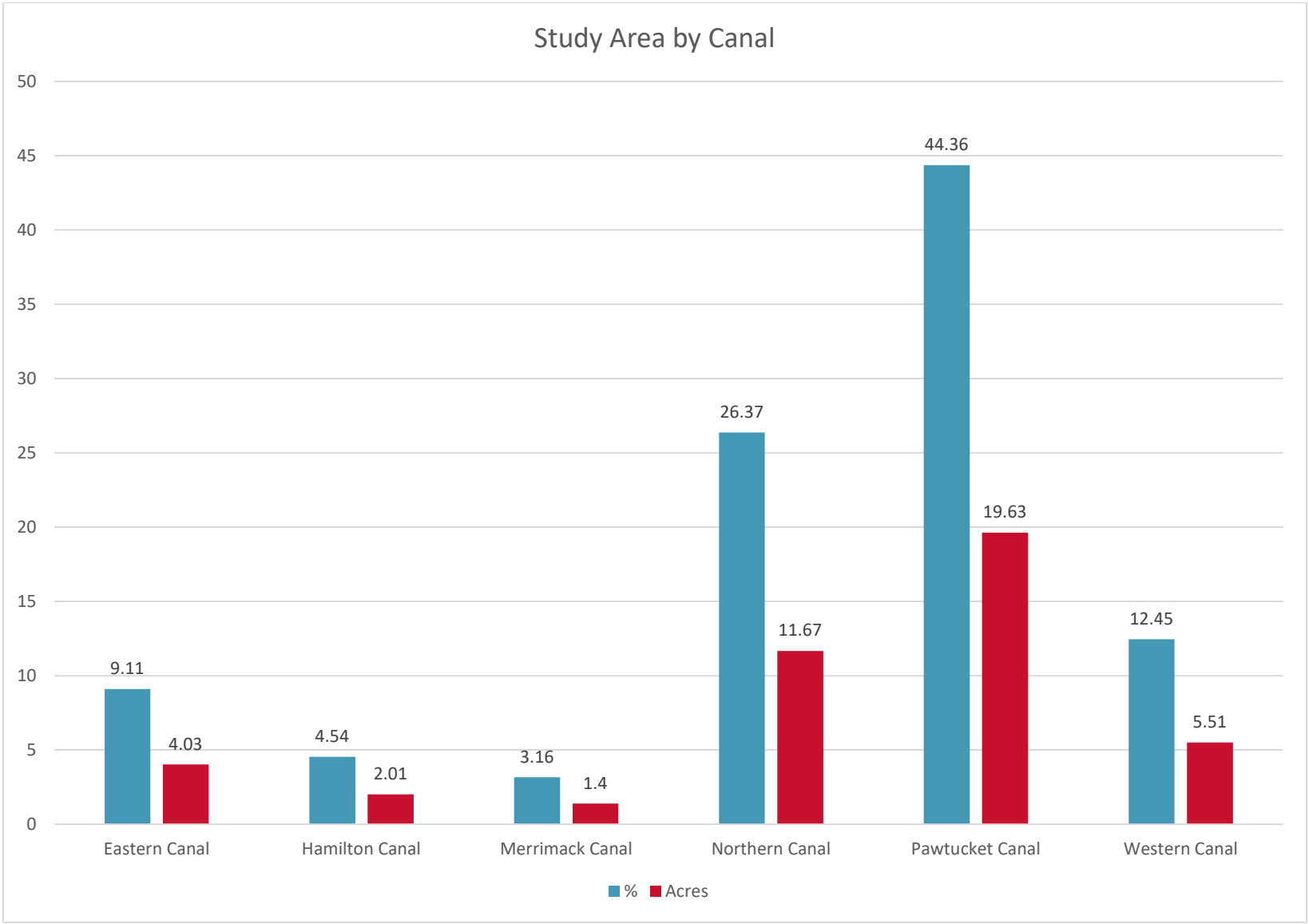
[4]This Vegetation Polygon/Point Identifier has a photograph(s) included in Appendix J.

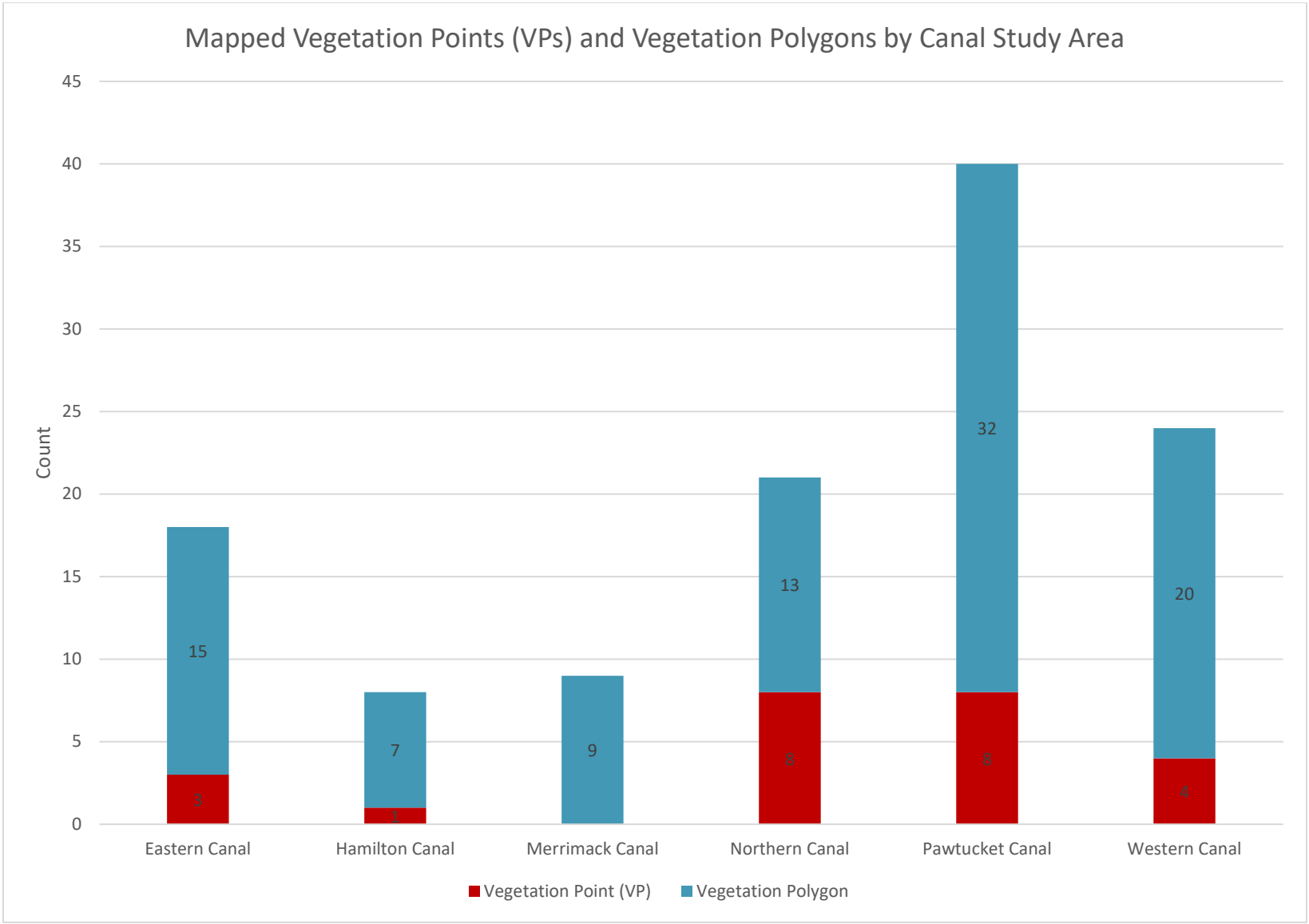
[5] Vegetation Polygon/Point Identifier 28 was not included in final results.

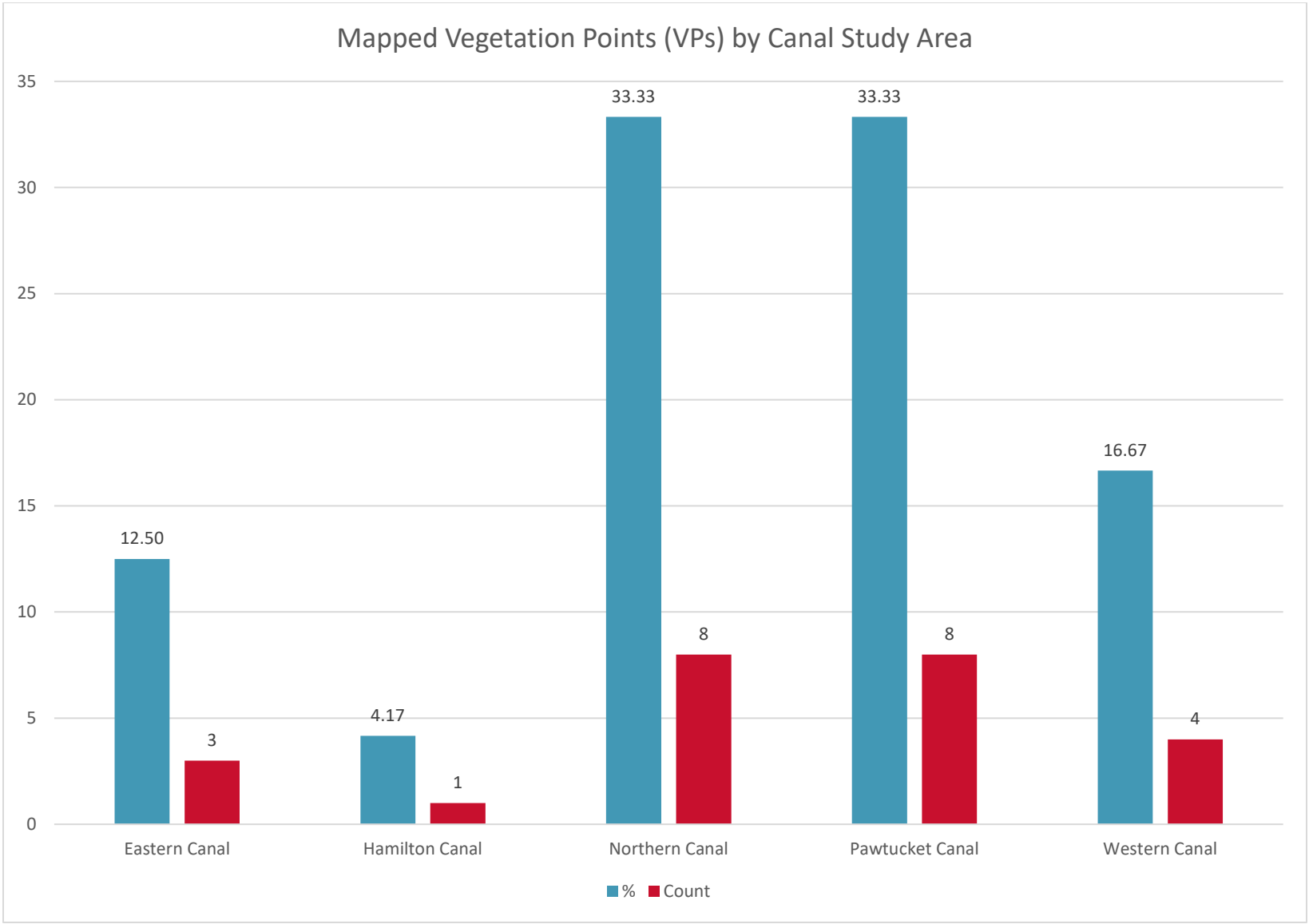
Appendix I - Visual Survey for Vegetation Growth Data Summary

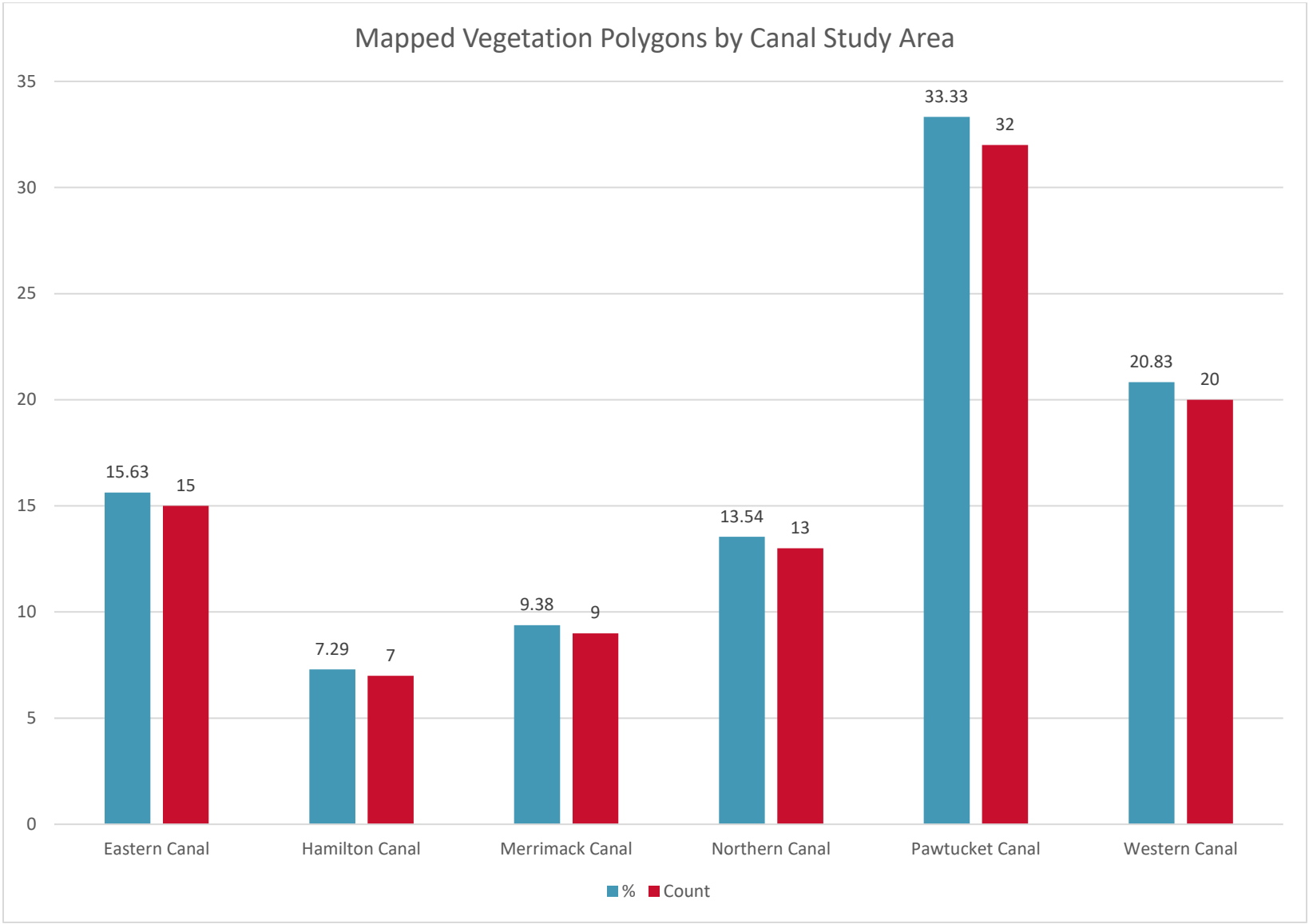
Summary of Visual Survey for Vegetation Growth Data

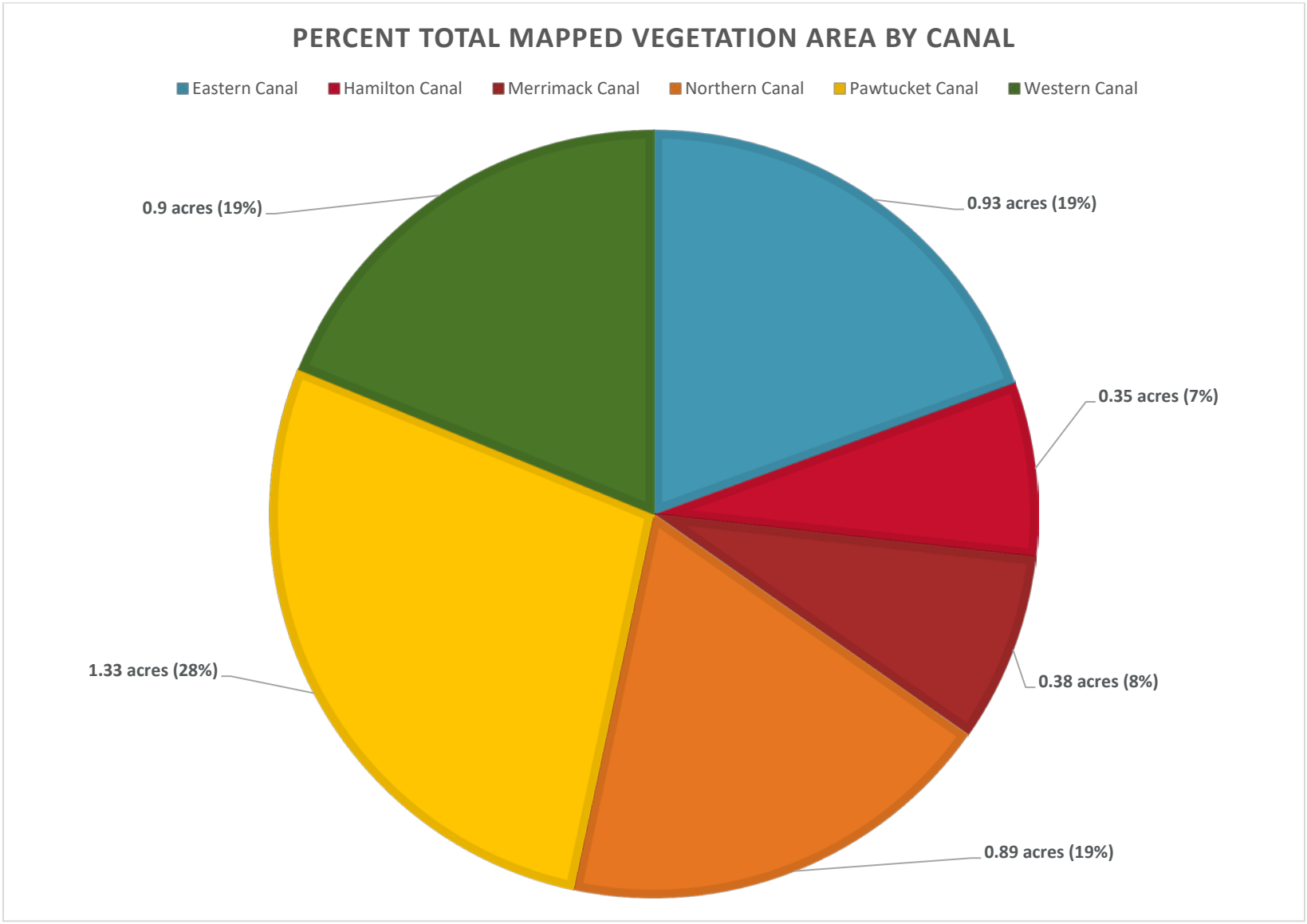

Mapped Vegetation Points (VPs) and Vegetation Polygons by Total Study Area
120
100
80
60
40
20
0
20
24
80
96
Vegetation Points (VPs)
Vegetation Polygons
% Count


Study Area by Canal
50
45
40
35
30
25
20
15
10
5
0
9.11
4.03
4.54
2.01
3.16
1.4
26.37
11.67
44.36
19.63
12.45
5.51
Eastern Canal
Hamilton Canal
Merrimack Canal
Northern Canal
Pawtucket Canal
Western Canal
% Acres

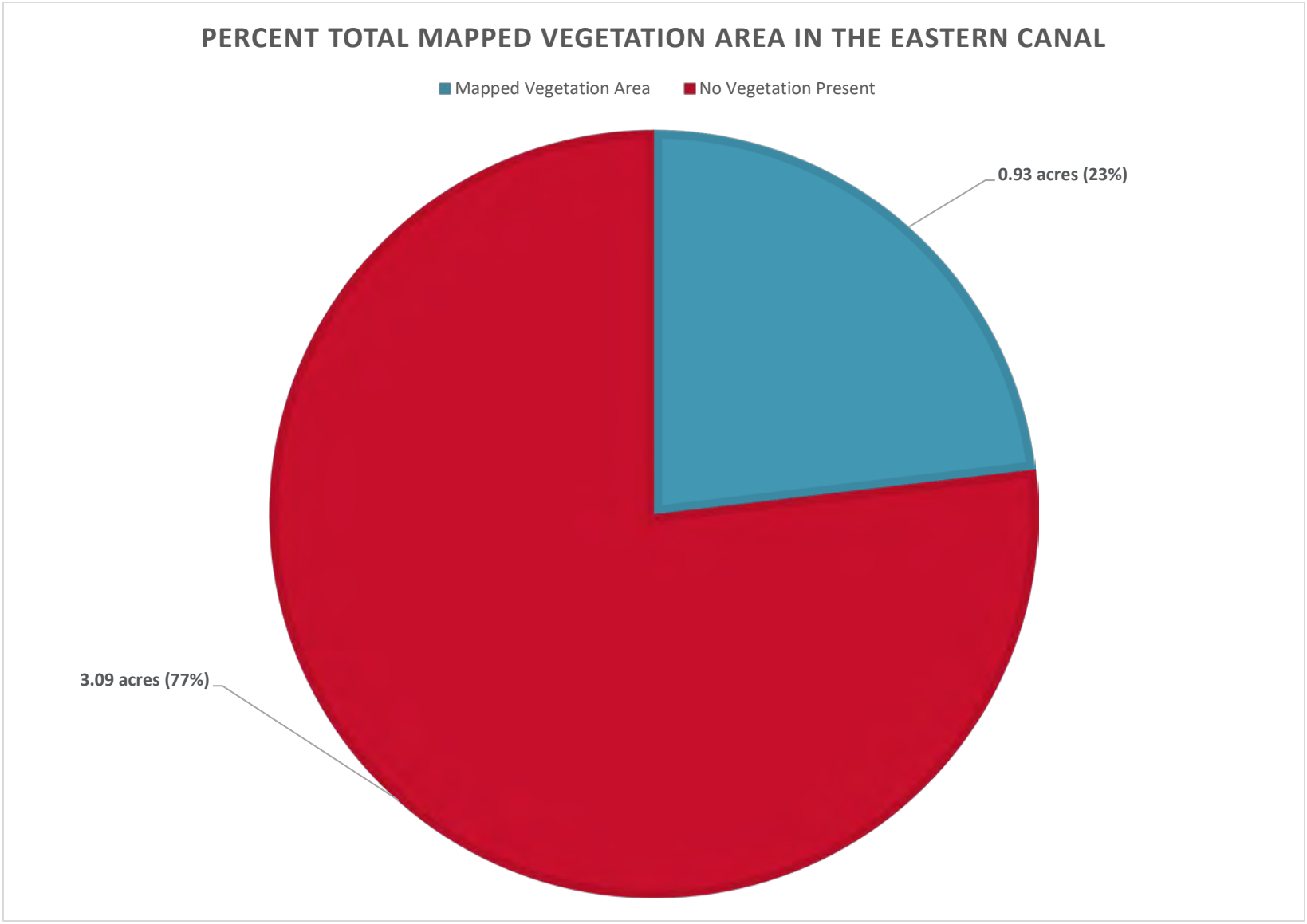

Mapped Vegetation Points (VPs) and Vegetation Polygons by Canal Study Area
Count
45
40
35
30
25
20
15
10
5
0
15
3
7
1
9
13
8
32
8
20
4
Eastern Canal
Hamilton Canal
Merrimack Canal
Northern Canal
Pawtucket Canal
Western Canal
Vegetation Point (VP)
Vegetation Polygon


Mapped Vegetation Points (VPs) by Canal Study Area
35
30
25
20
15
10
5
0
12.50
3
4.17
1
33.33
8
33.33
8
16.67
4
Eastern Canal
Hamilton Canal
Northern Canal
Pawtucket Canal
Western Canal
% Count

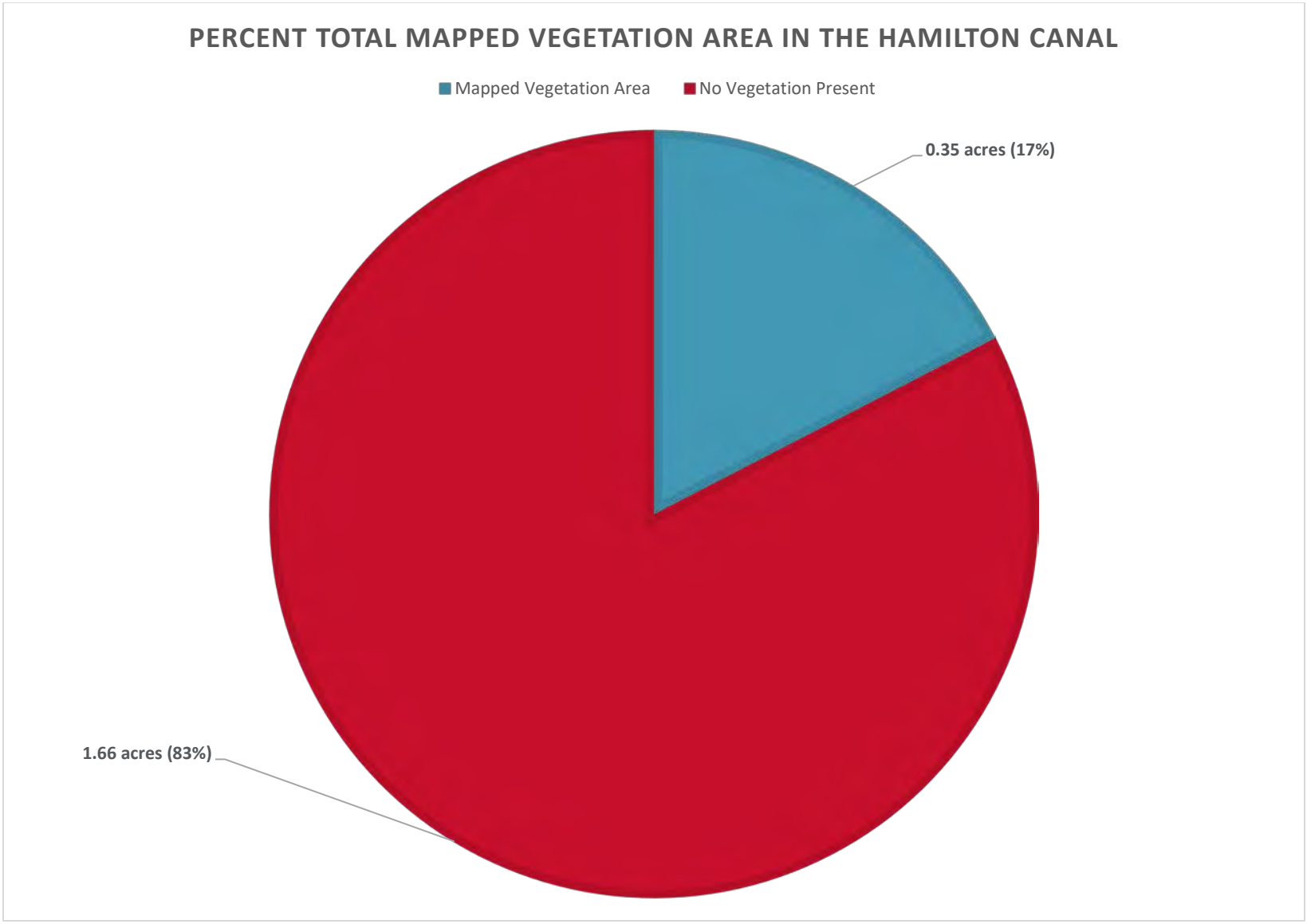

Mapped Vegetation Polygons by Canal Study Area
35
30
25
20
15
10
5
0
15.63
15
7.29
7
9.38
9
13.54
13
33.33
32
20.83
20
Eastern Canal
Hamilton Canal
Merrimack Canal
Northern Canal
Pawtucket Canal
Western Canal
% Count



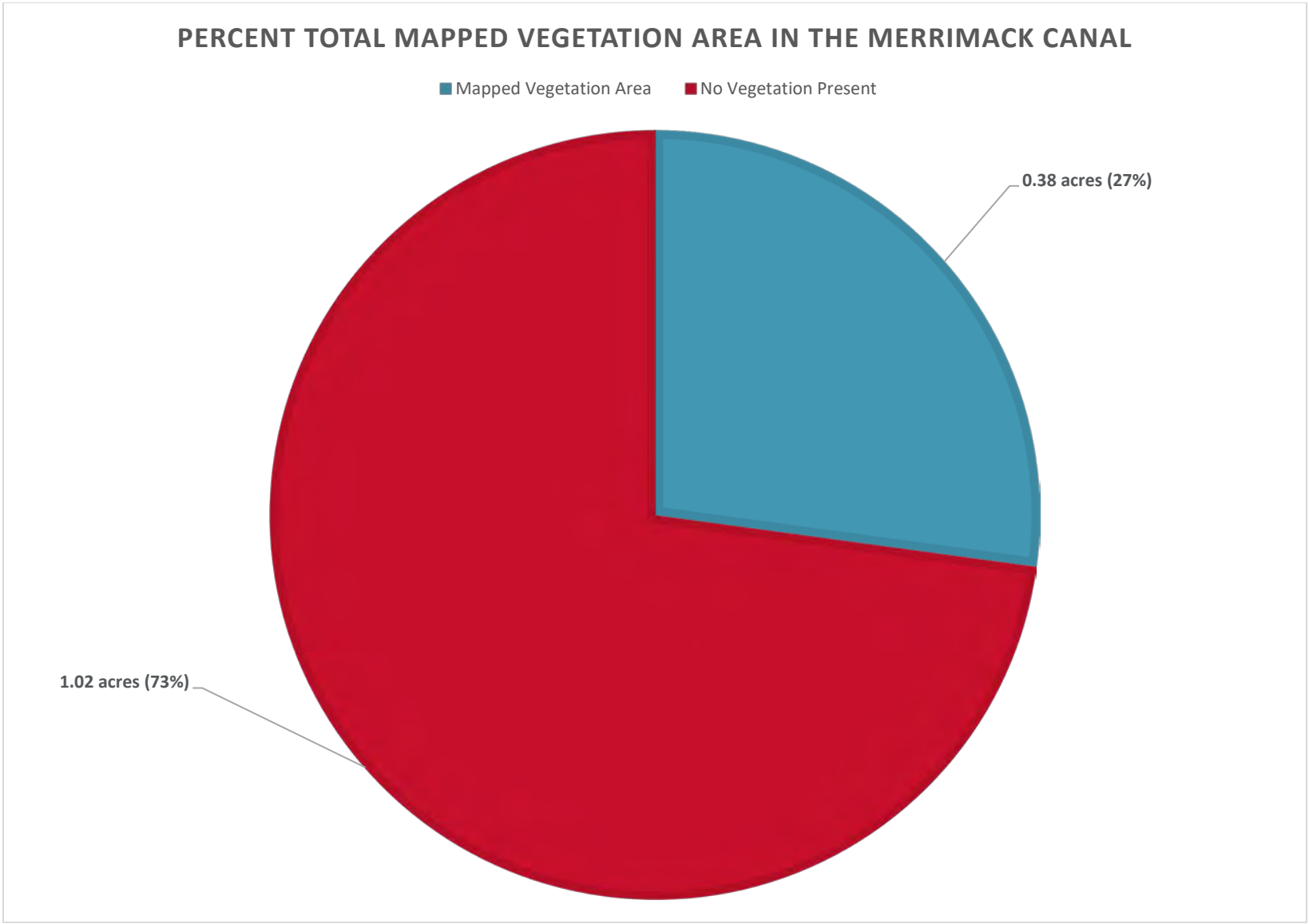
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



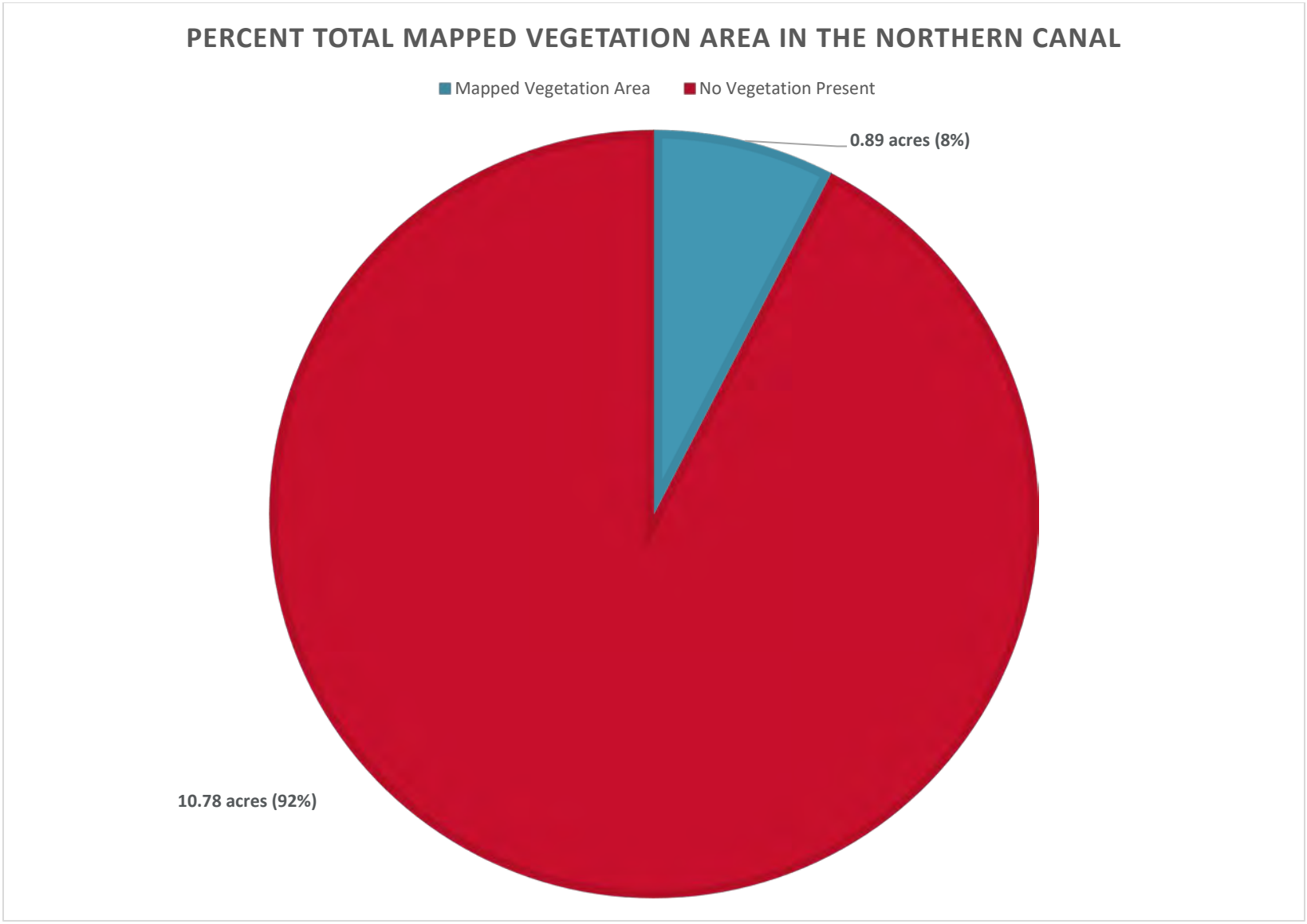
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



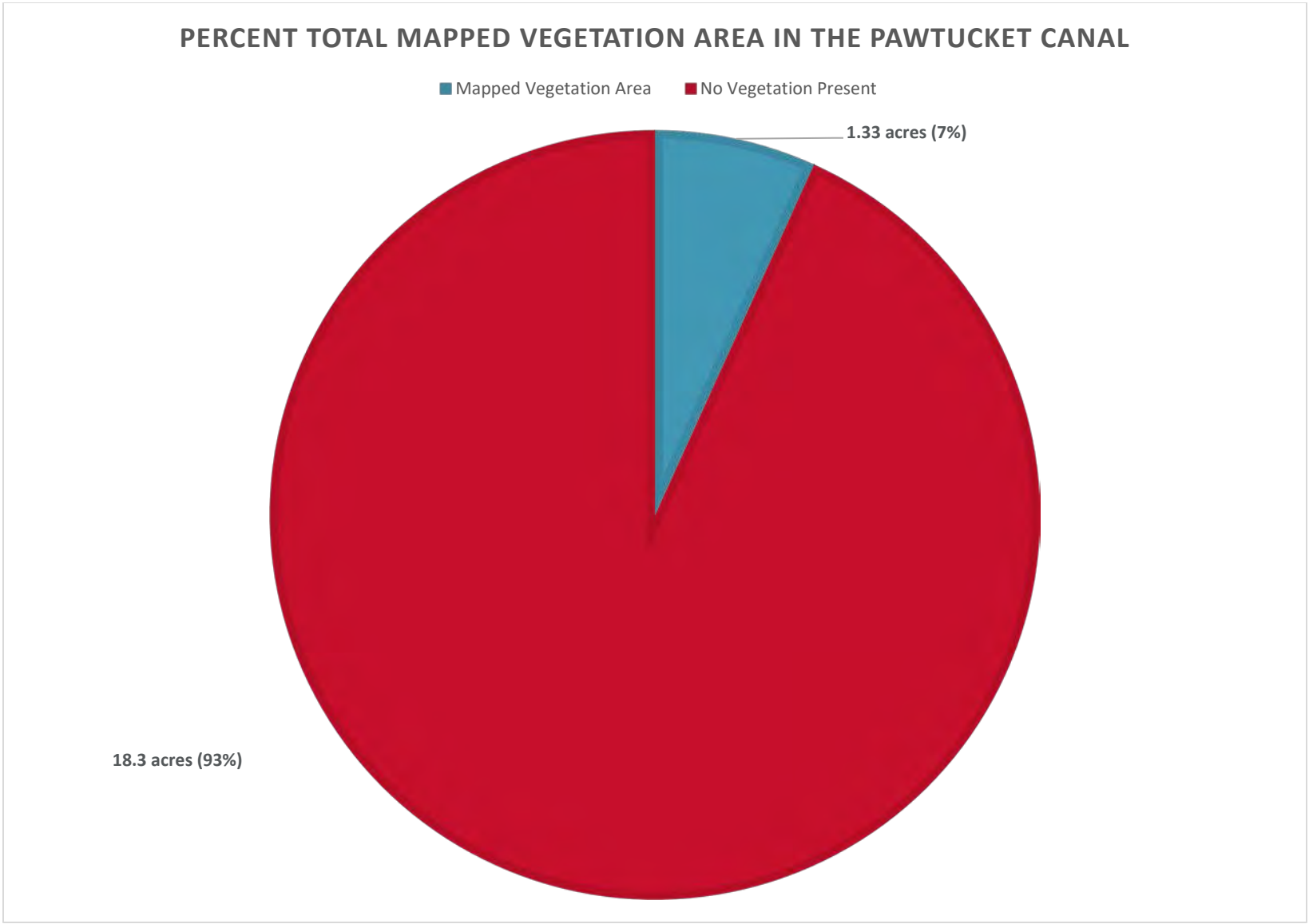
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



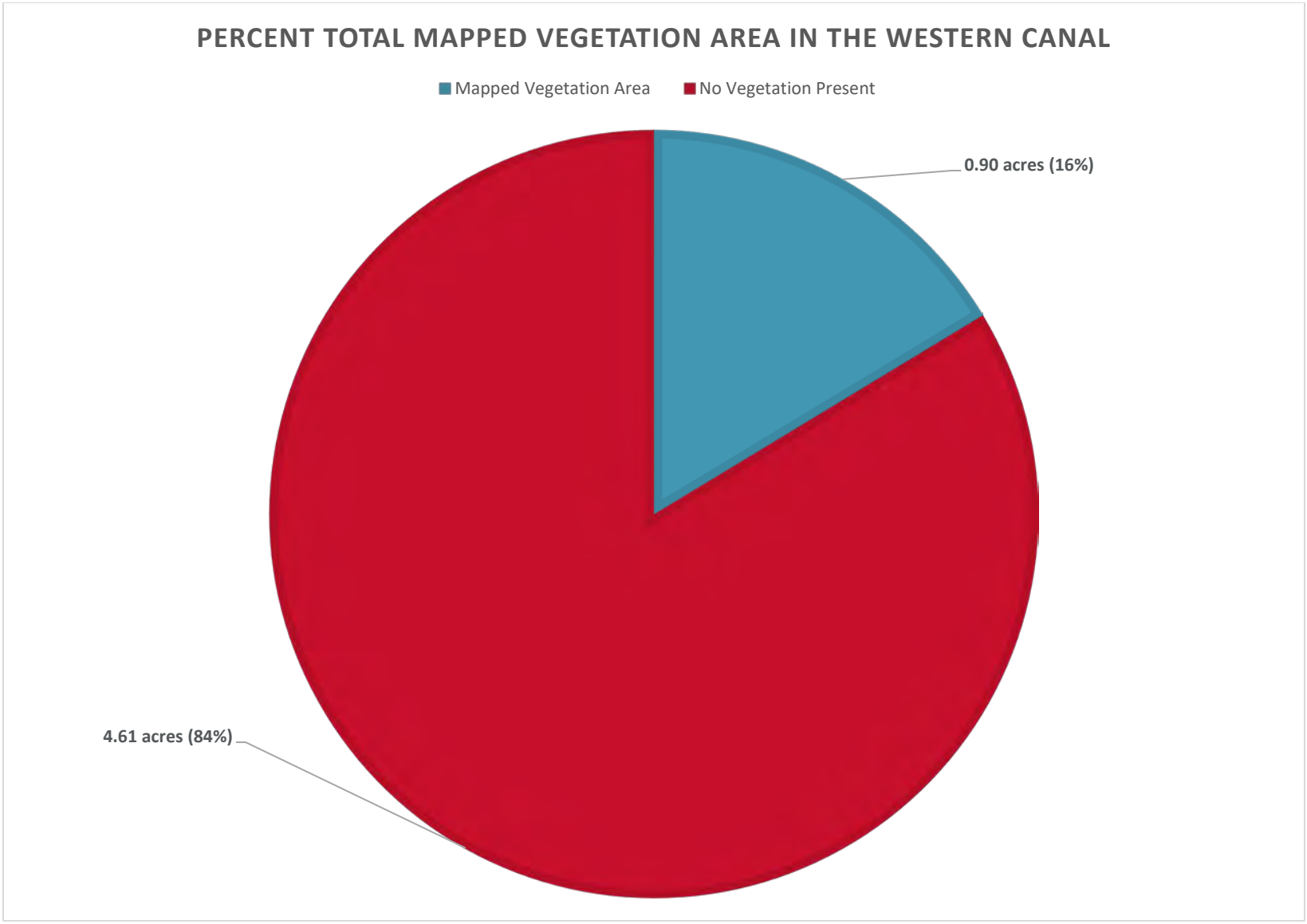
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



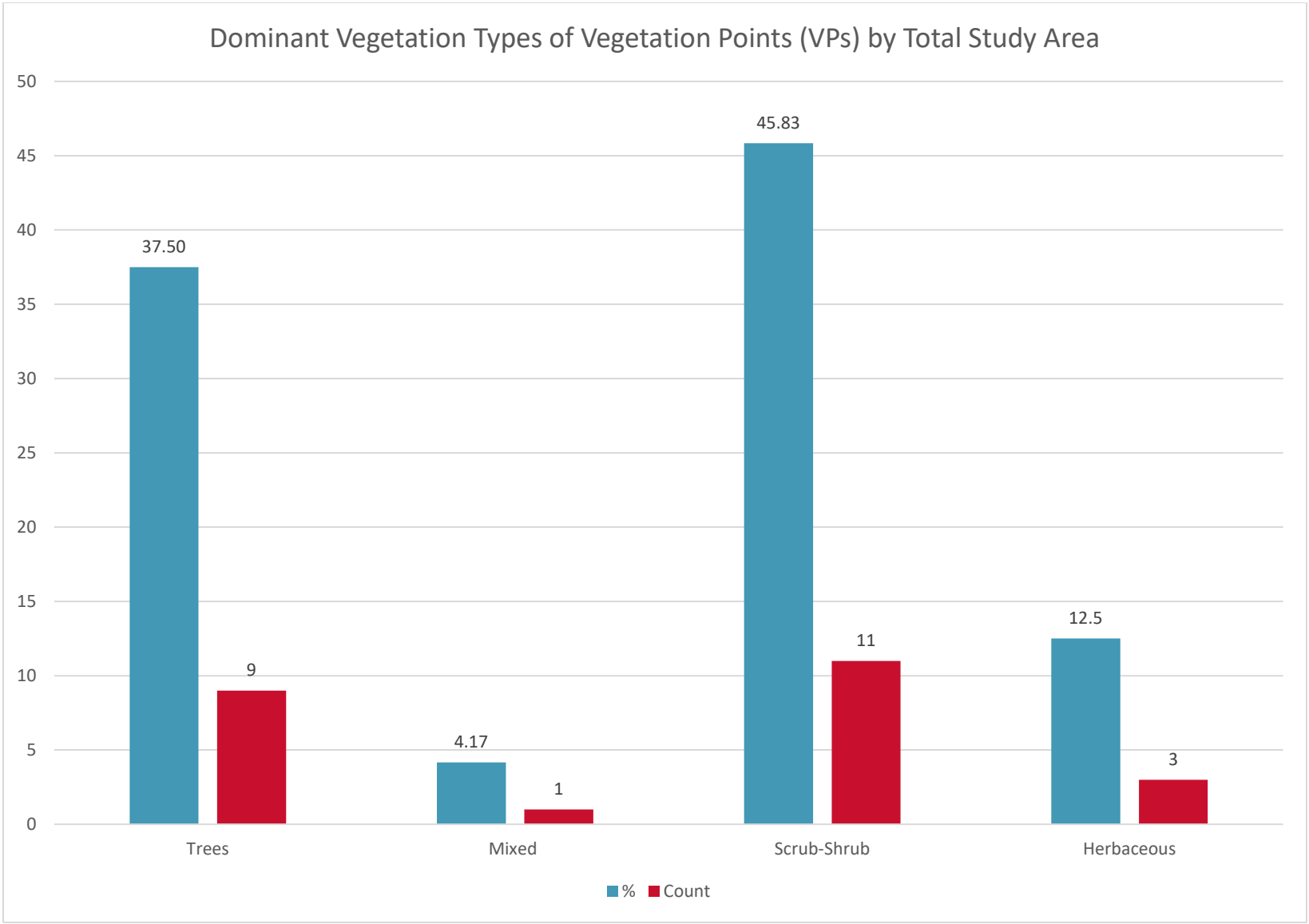
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations

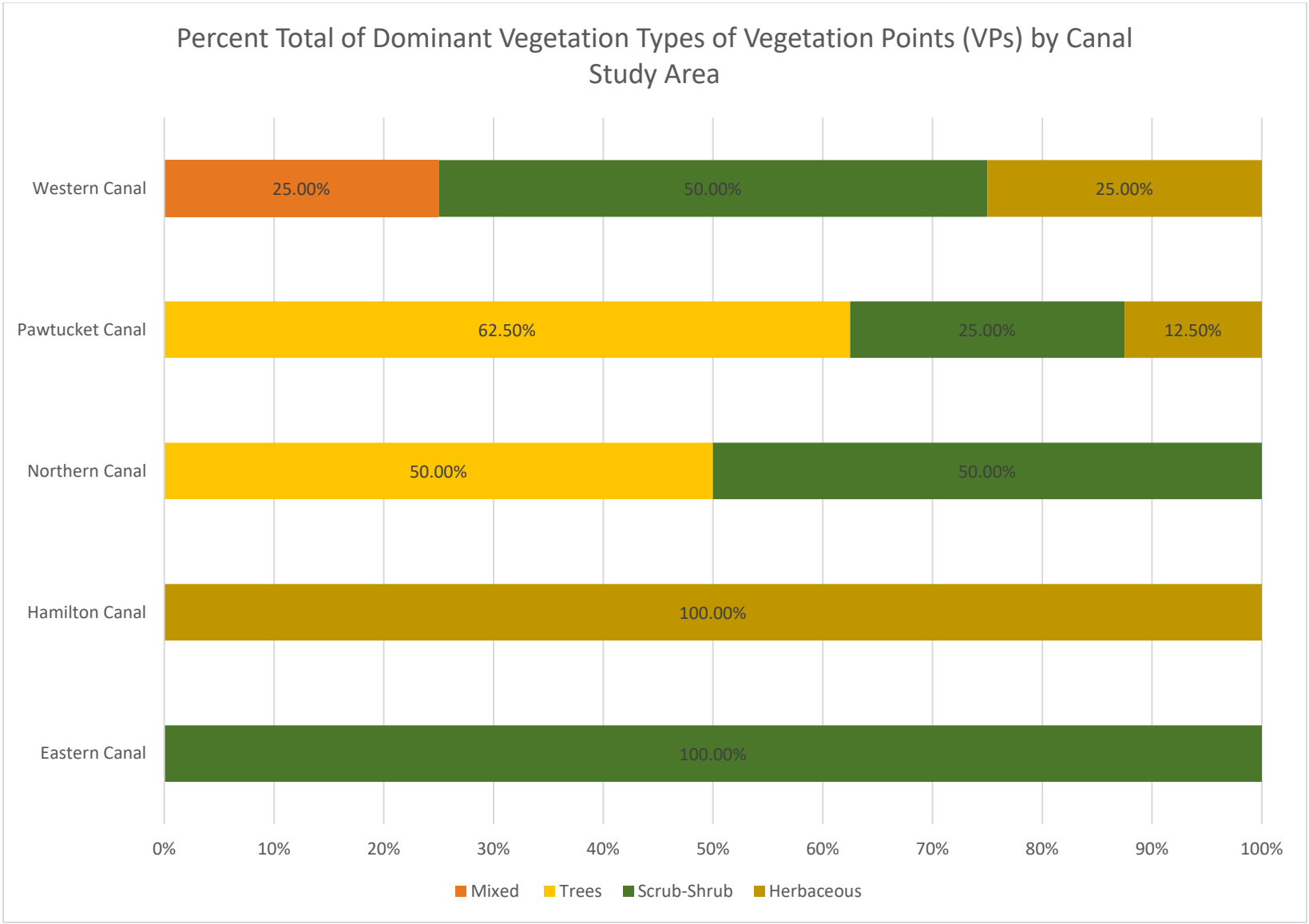


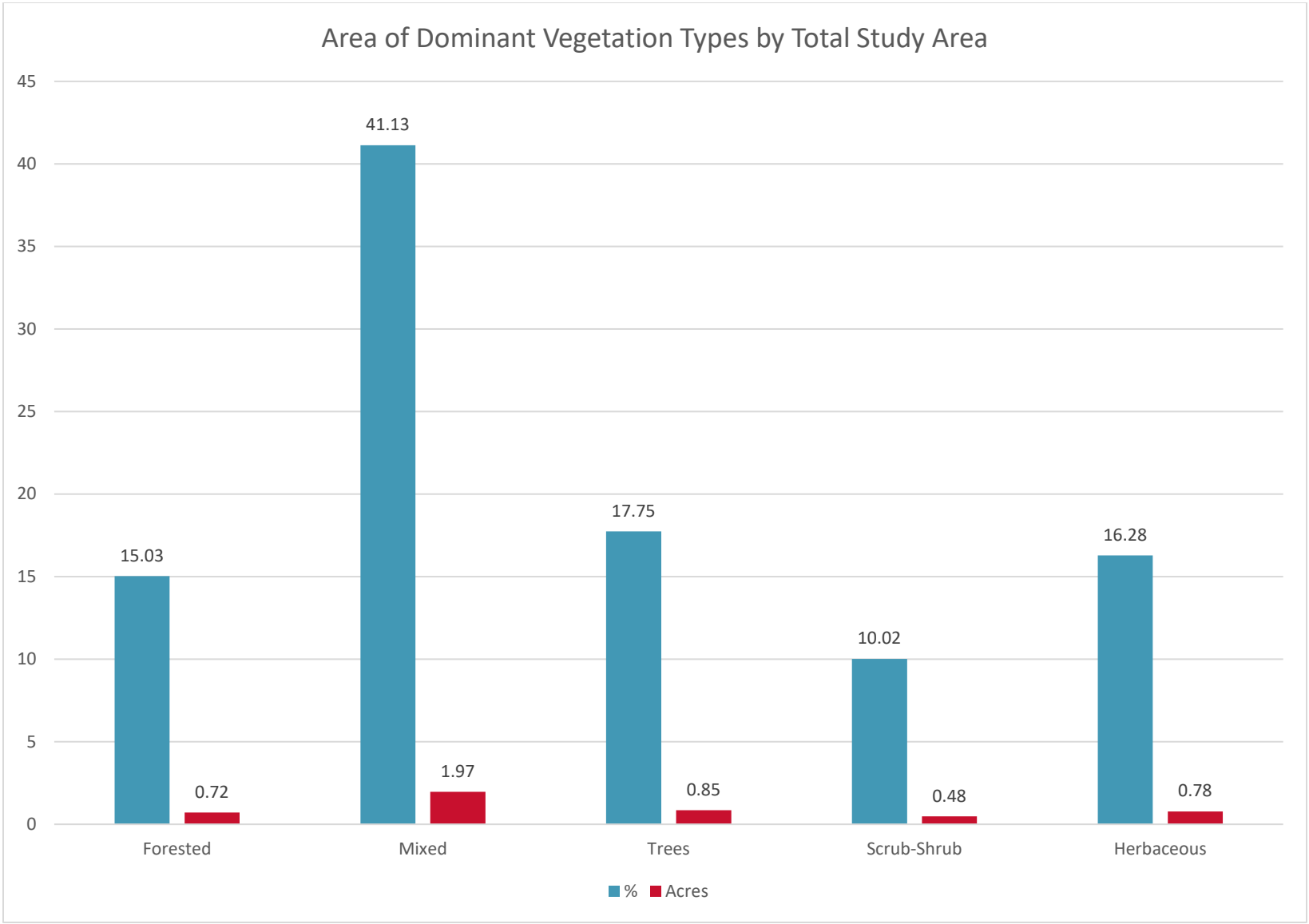
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



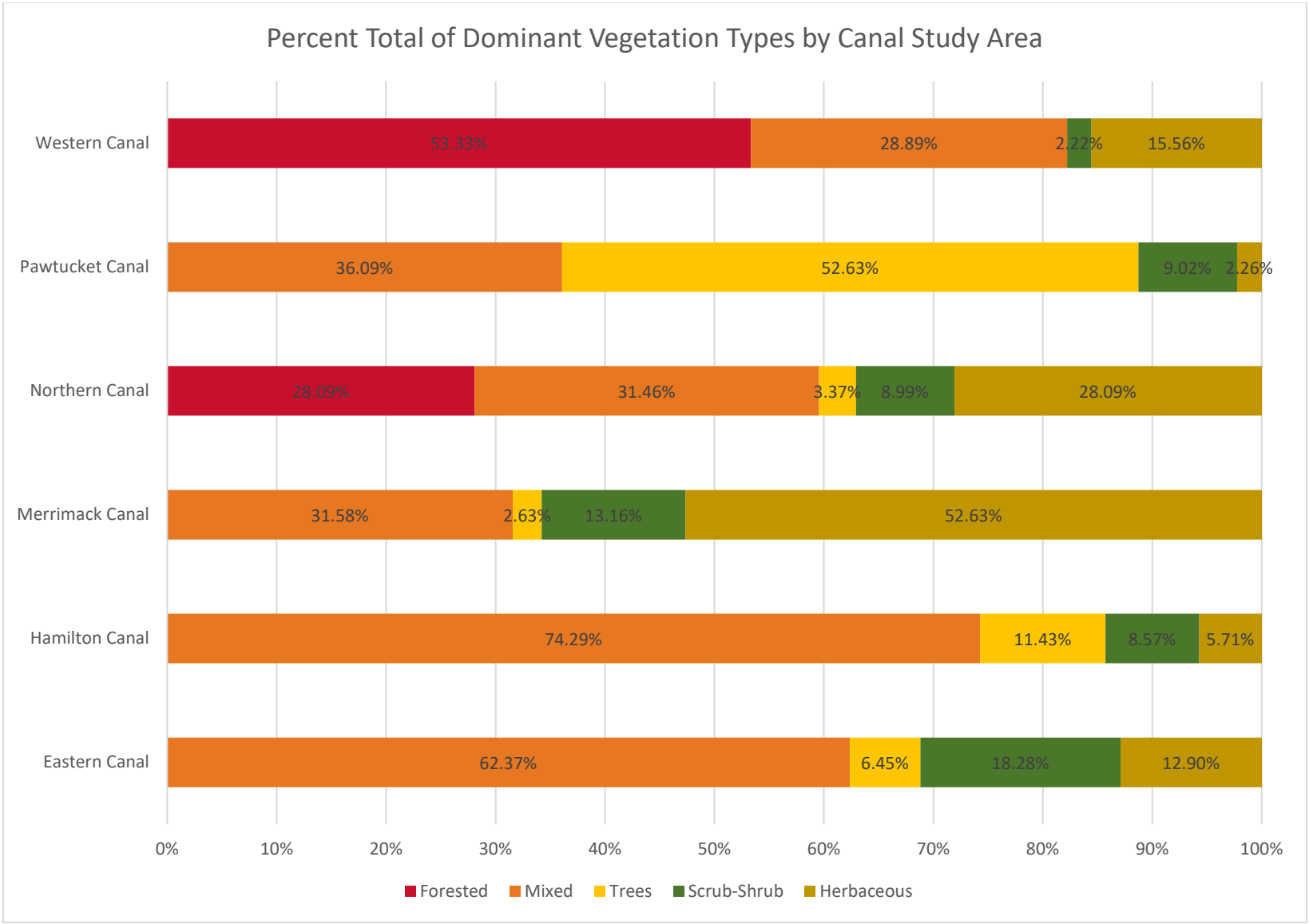
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations


Dominant Vegetation Types of Vegetation Points (VPs) by Total Study Area
50
45
40
35
30
25
20
15
10
5
0
37.50
9
4.17
1
45.83
11
12.5
3
Trees
Mixed
Scrub-Shrub
Herbaceous
% Count

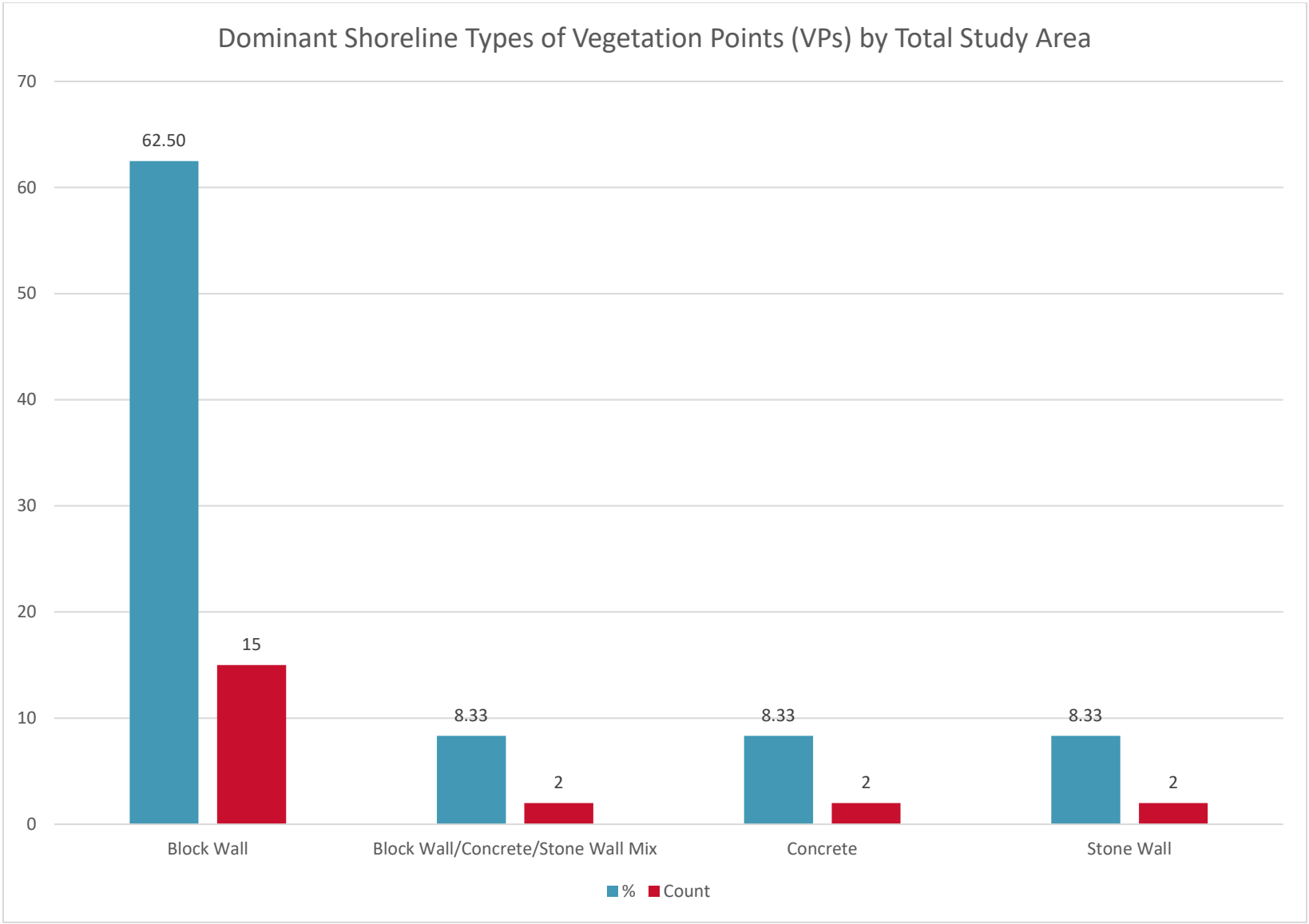

Percent Total of Dominant Vegetation Types of Vegetation Points (VPs) by Canal Study Area
Western Canal
Pawtucket Canal
Northern Canal
Hamilton Canal
Eastern Canal
25.00%
50.00%
25.00%
62.50%
25.00%
12.50%
50.00%
50.00%
100.00%
100.00%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Mixed
Trees
Scrub-Shrub
Herbaceous

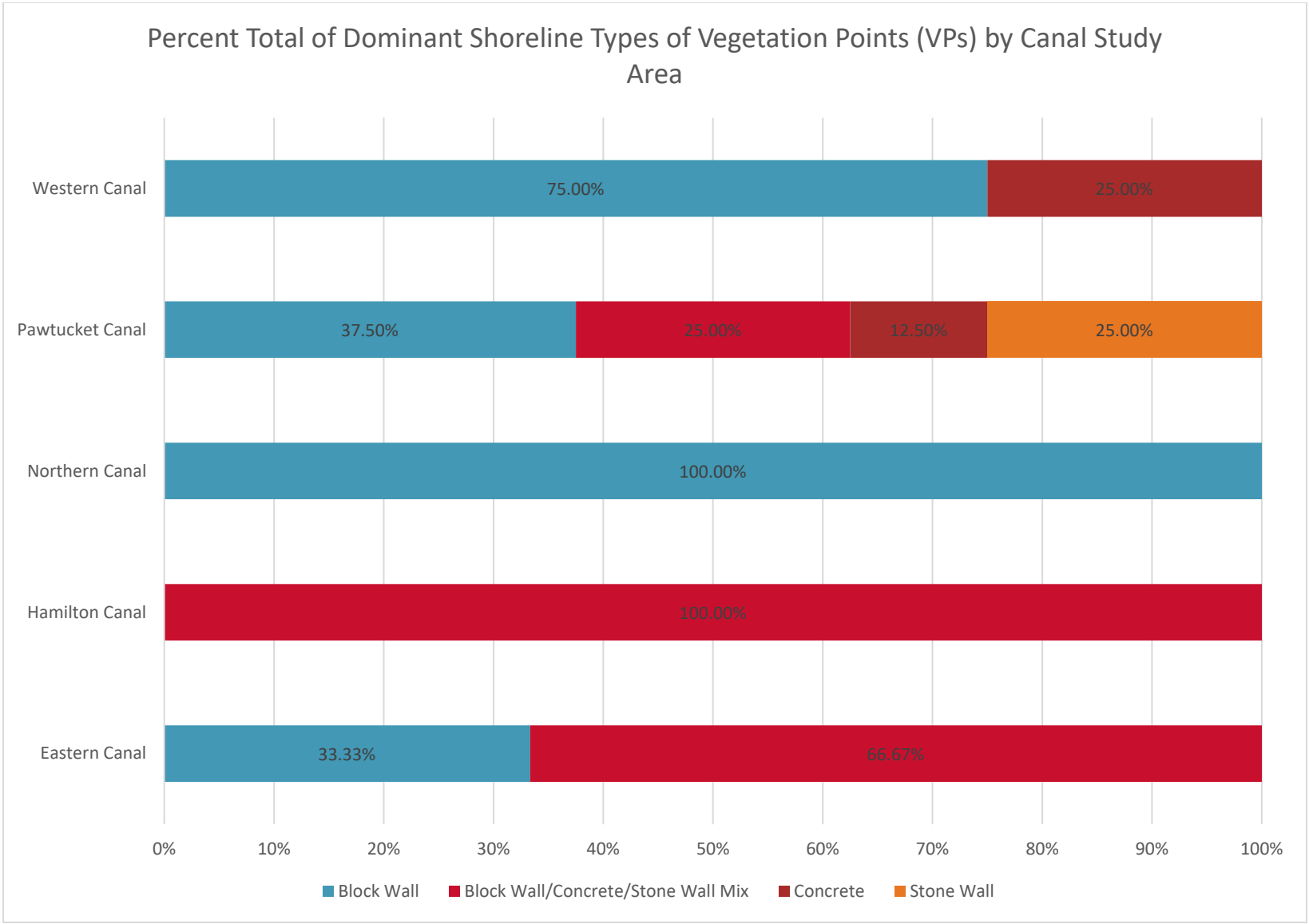


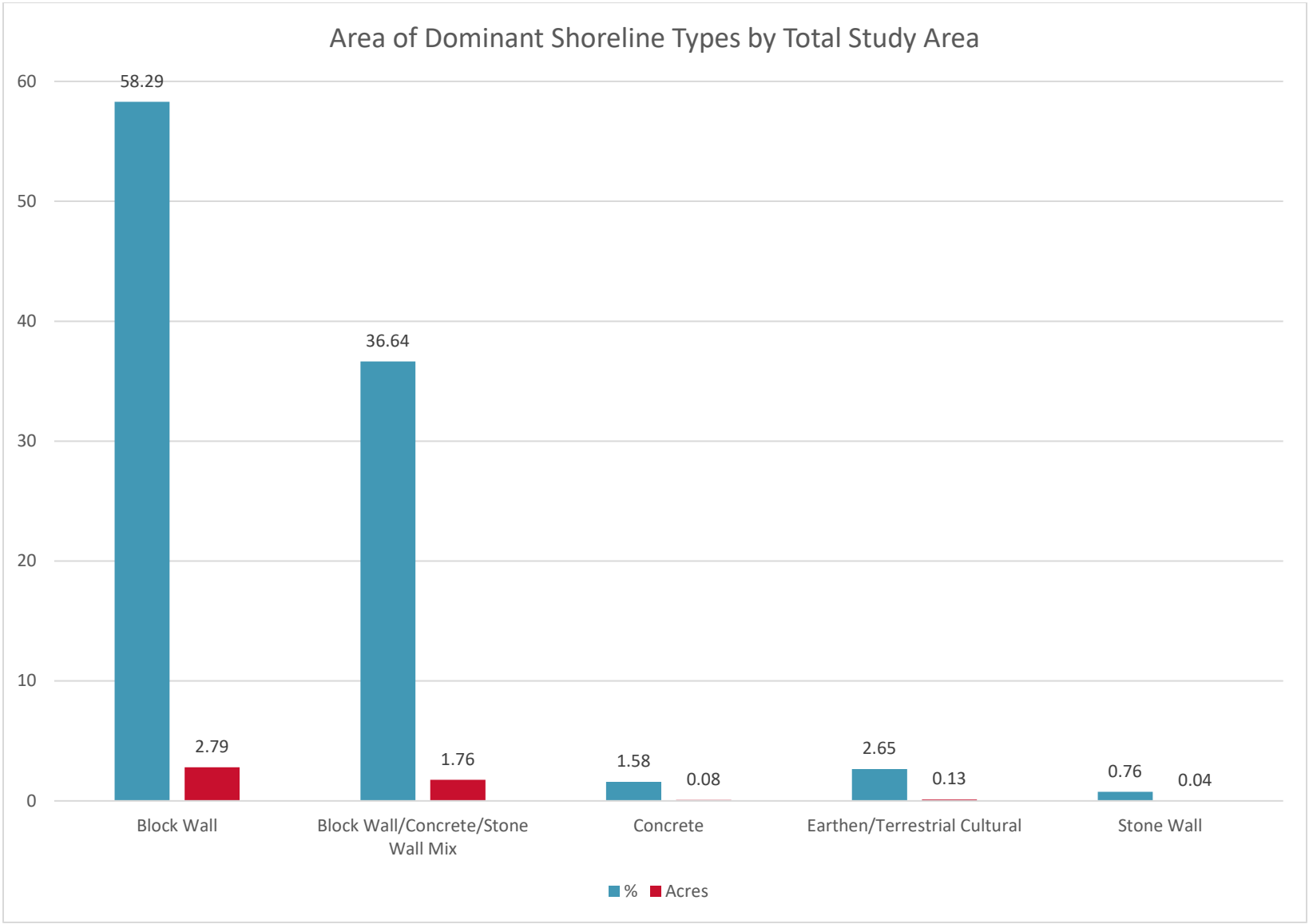
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



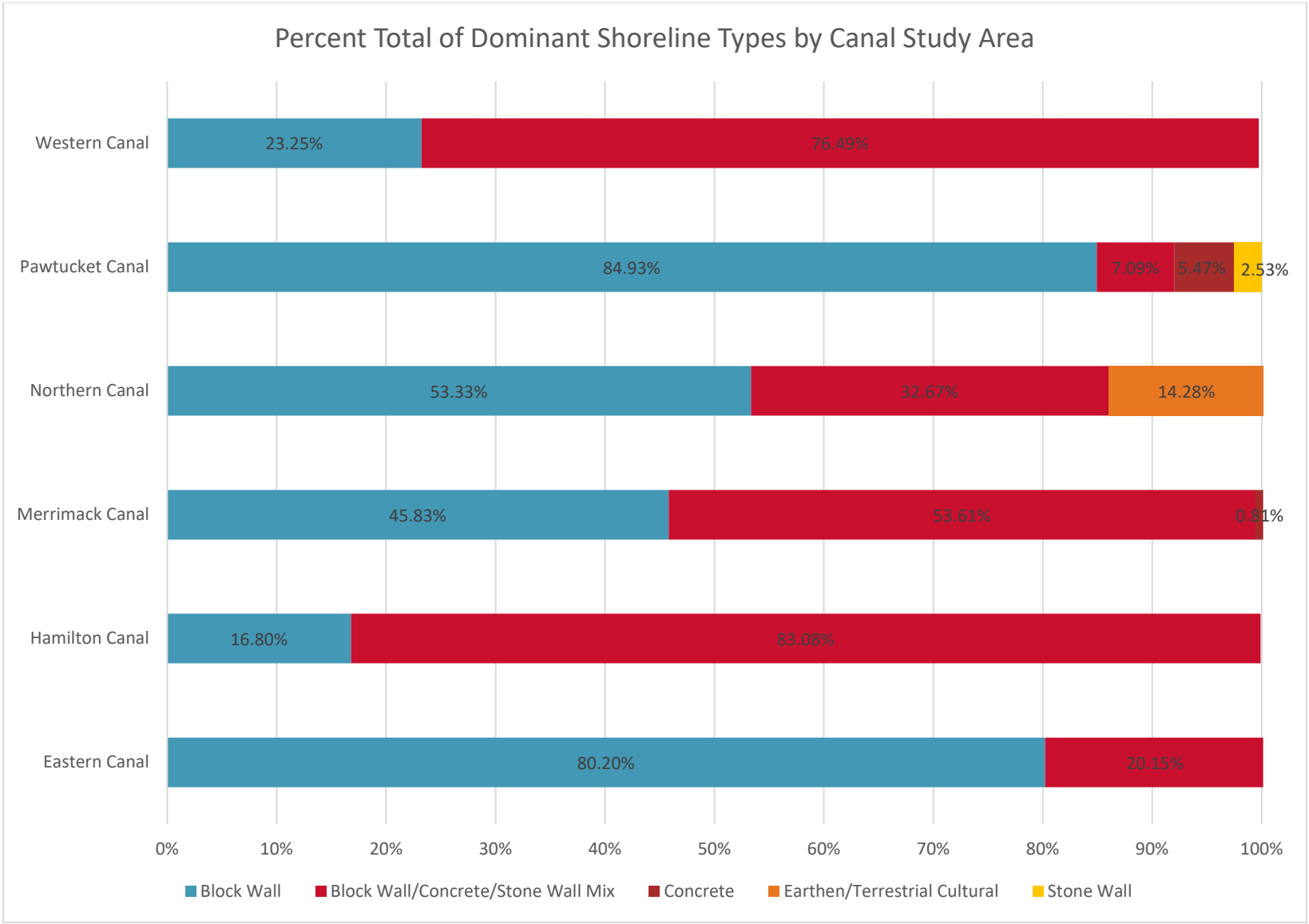
Note: Percent totals are based on mapped vegetation acreages from Vegetation Polygons; Vegetation Points (VPs) are not included in mapped vegetation acreage calculations


Dominant Shoreline Types of Vegetation Points (VPs) by Total Study Area
70
60
50
40
30
20
10
0
62.50
15
8.33
2
8.33
2
8.33
2
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
% Count

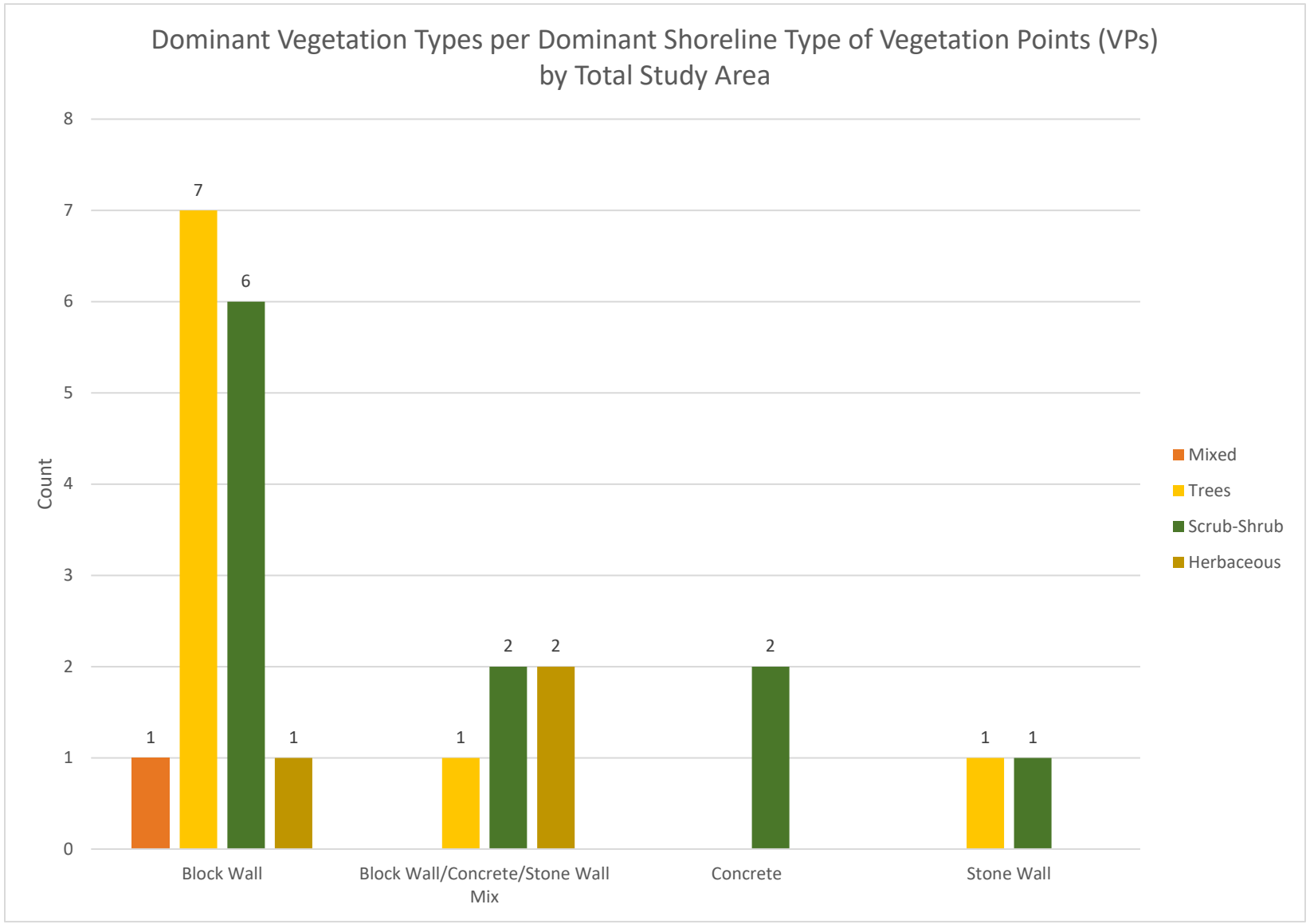

Percent Total of Dominant Shoreline Types of Vegetation Points (VPs) by Canal Study Area
Western Canal
75.00%
25.00%
Pawtucket Canal
37.50%
25.00%
12.50%
25.00%
Northern Canal
100.00%
Hamilton Canal
100.00%
Eastern Canal
33.33%
66.67%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall

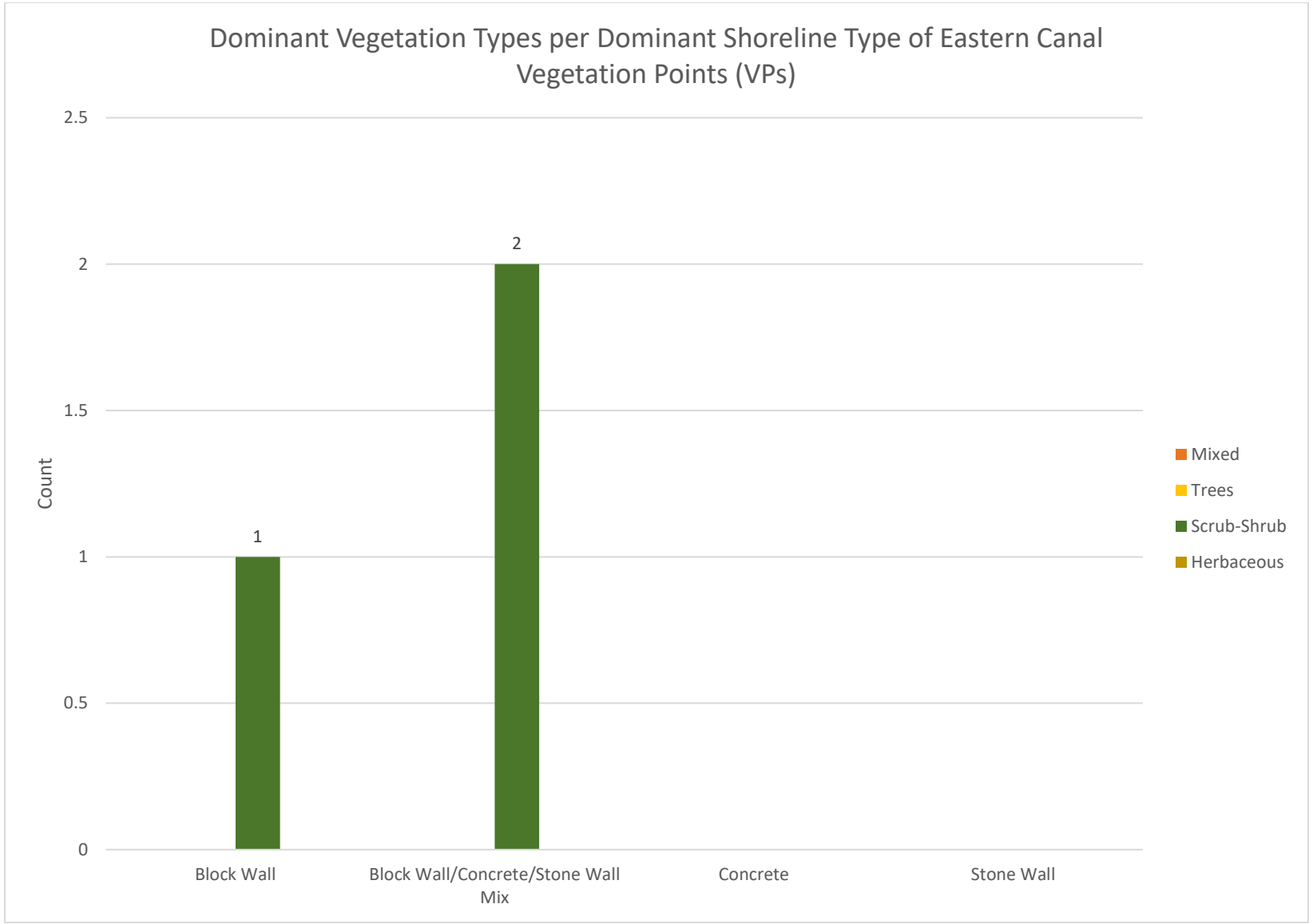


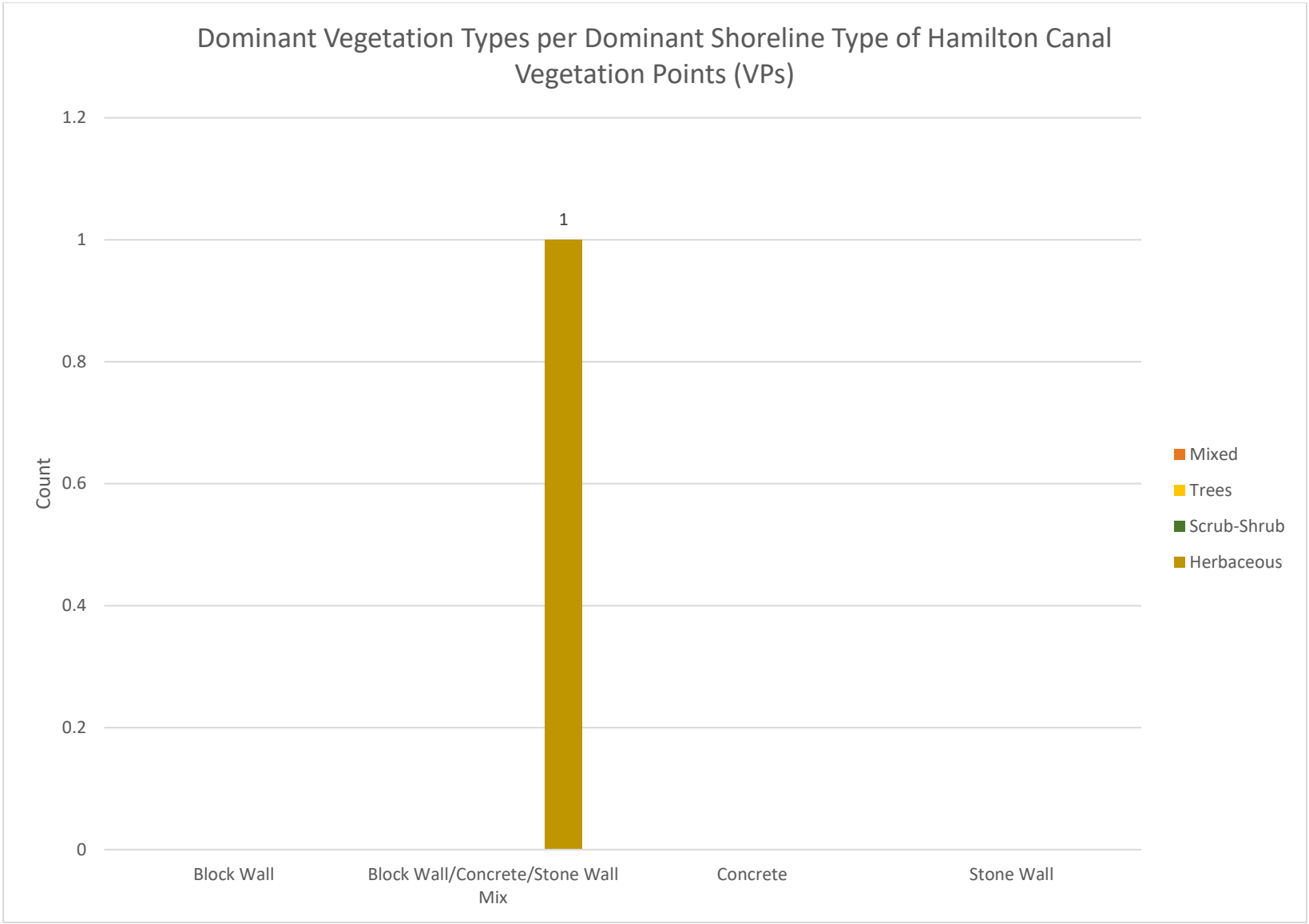
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations

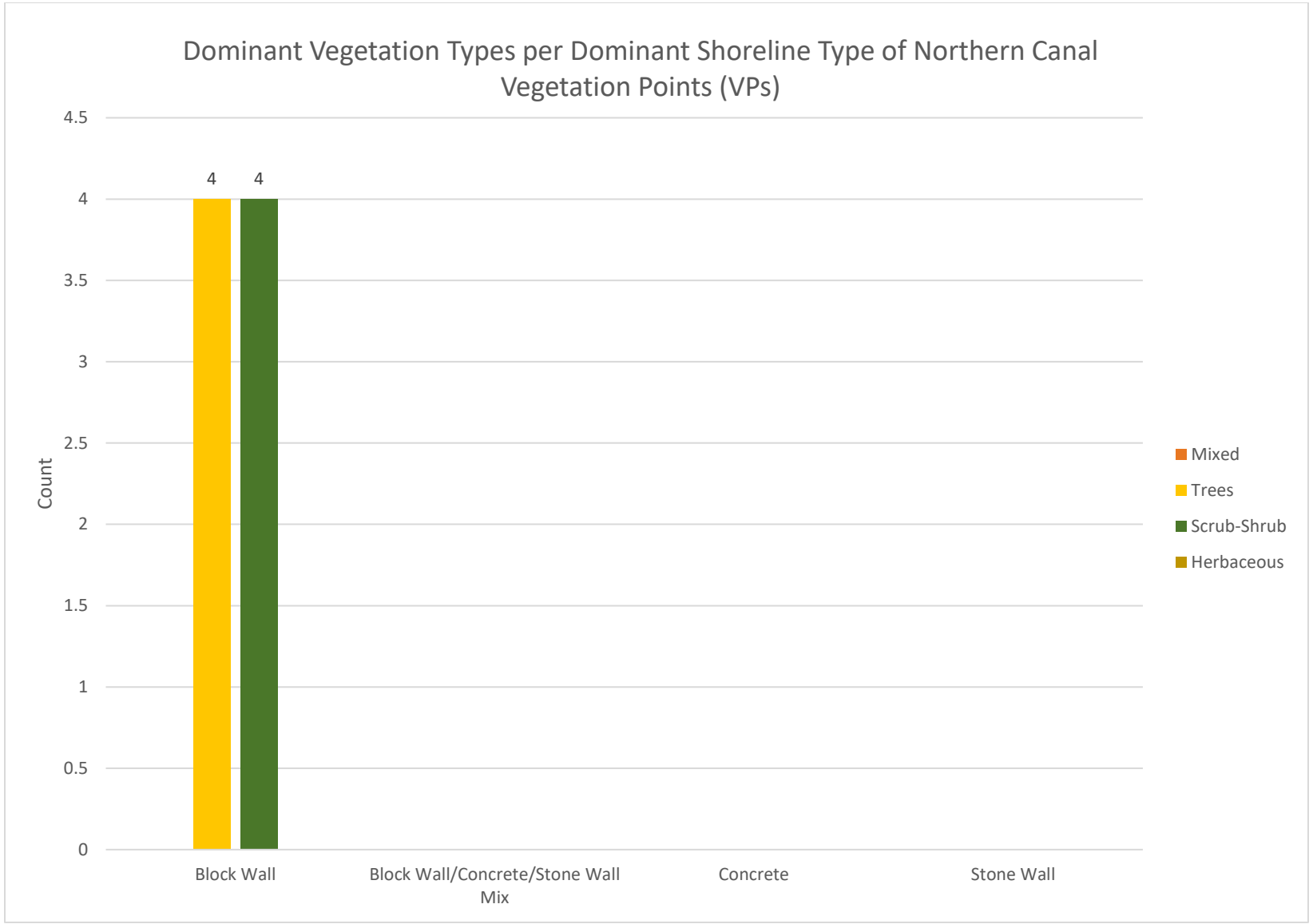


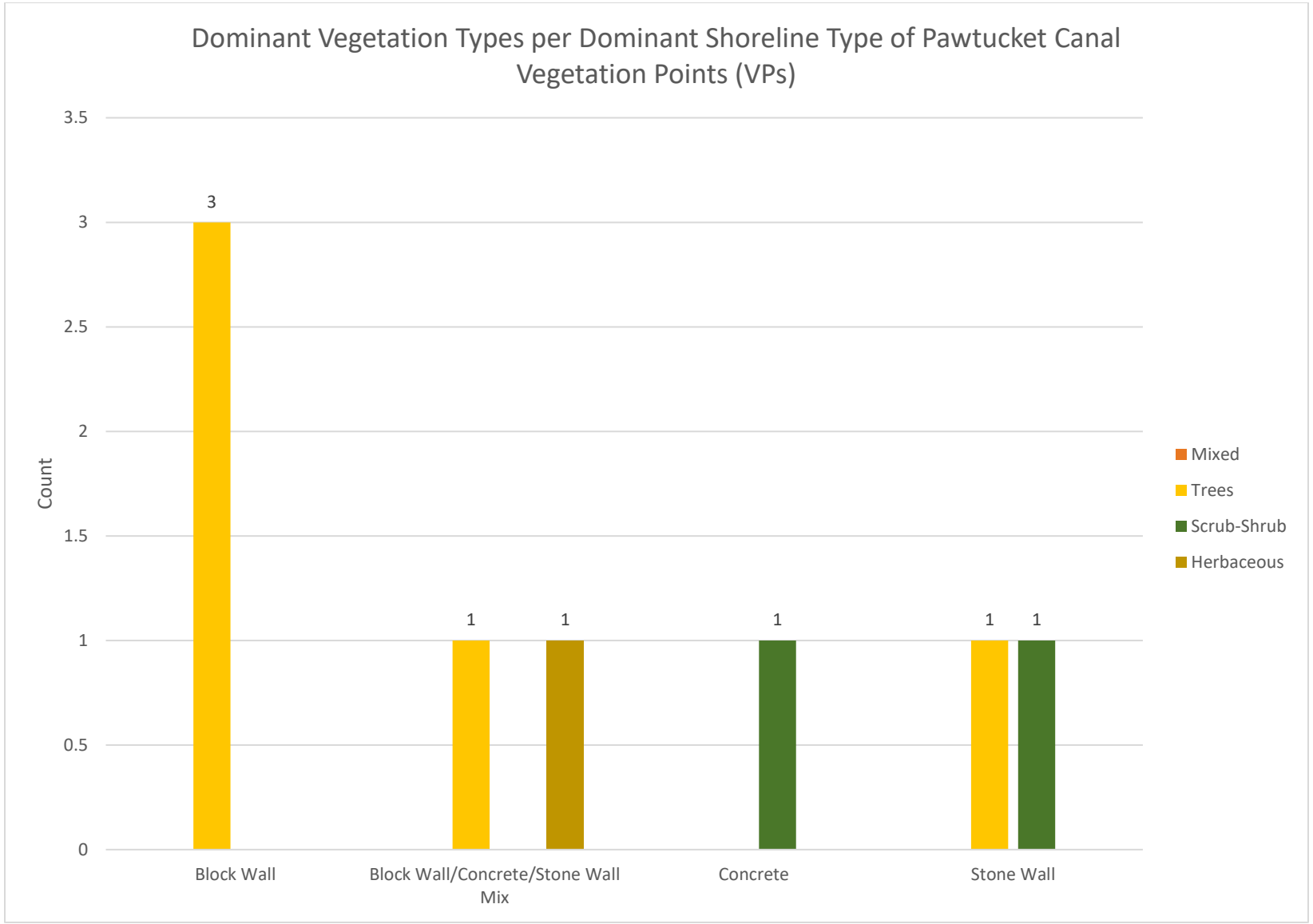
Note: Percent totals based on mapped vegetation acreages from Vegetation Polygons; Vegetation Points (VPs) are not included in mapped vegetation acreage calculations

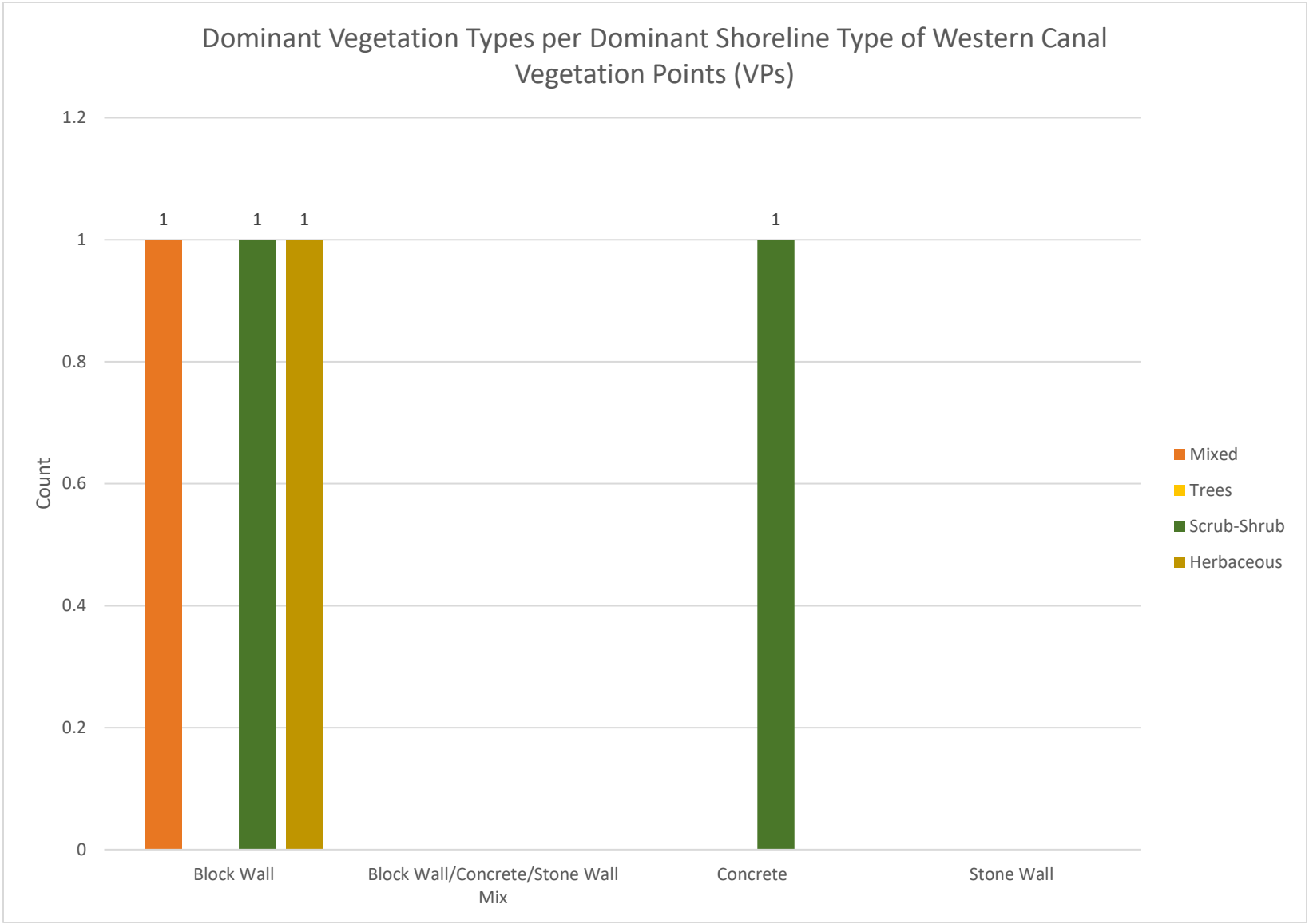

Dominant Vegetation Types per Dominant Shoreline Type of Vegetation Points (VPs) by Total Study Area
Count
8
7
6
5
4
3
2
1
0
1
7
6
1
1
2
2
2
1
1
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous

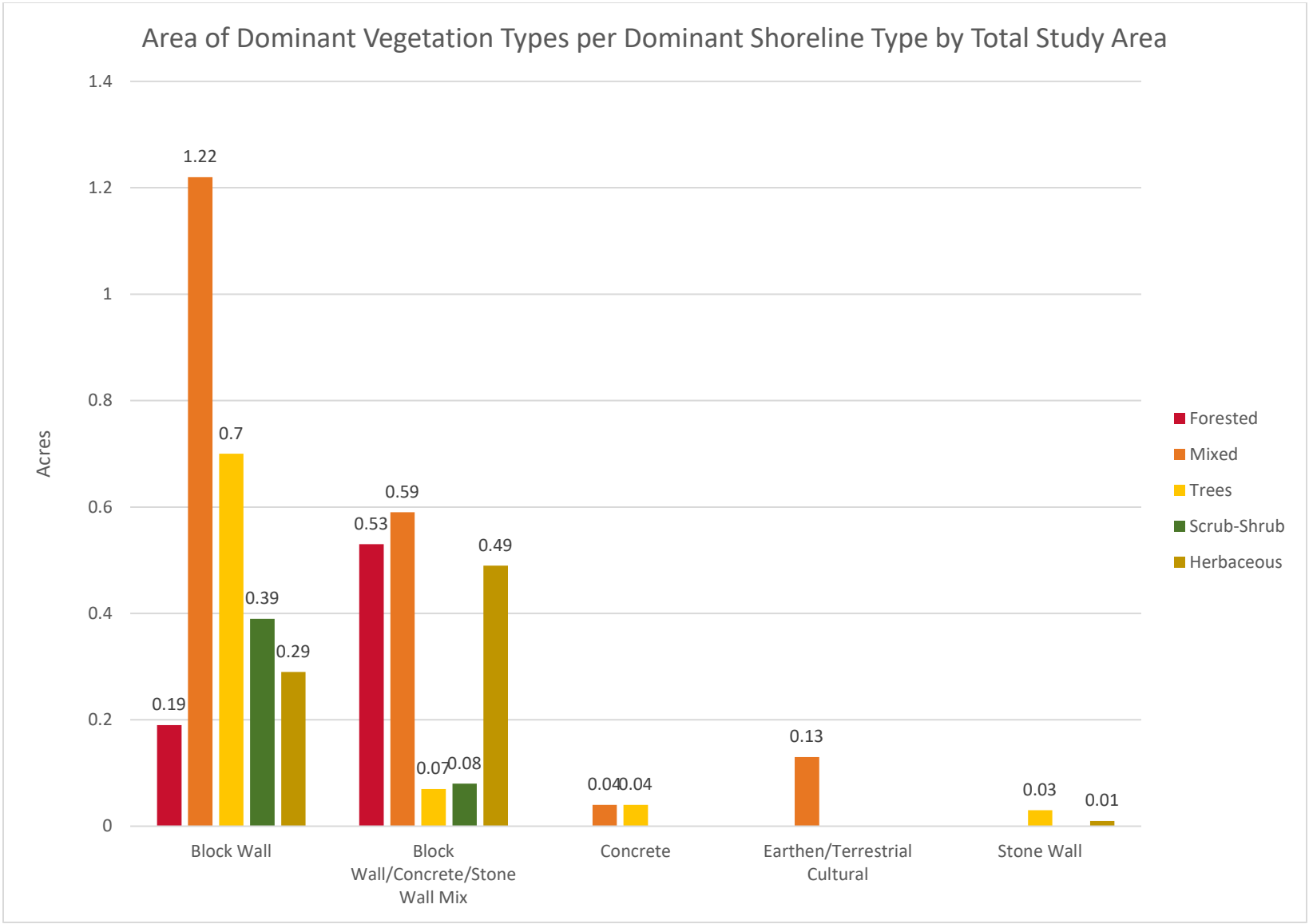

Dominant Vegetation Types per Dominant Shoreline Type of Eastern Canal
Vegetation Points (VPs)
2.5
2
1.5
1
0.5
0
Count
1
2
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous


Dominant Vegetation Types per Dominant Shoreline Type of Hamilton Canal
Vegetation Points (VPs)
1.2
1
0.8
0.6
0.4
0.2
0
Count
1
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous

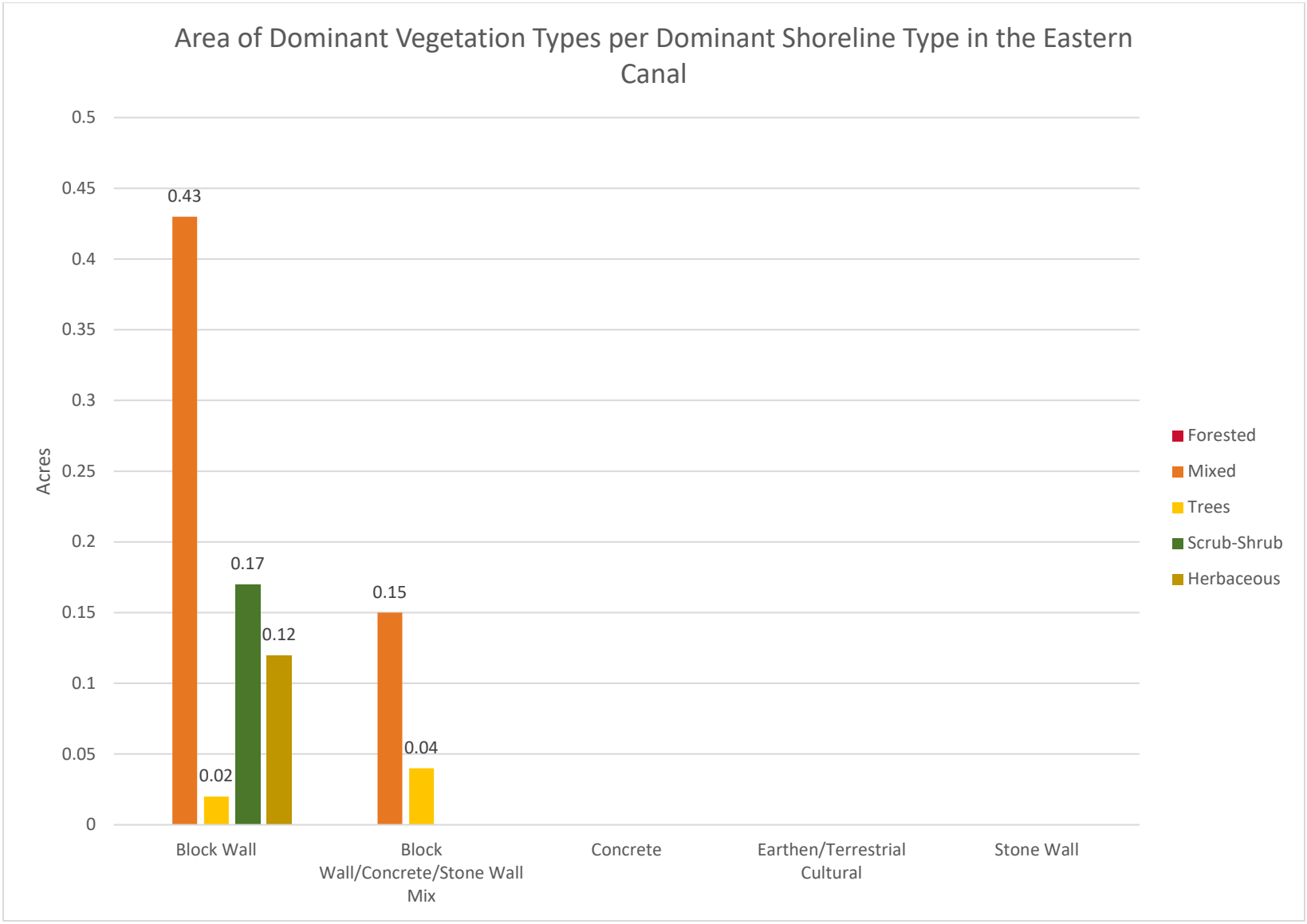

Dominant Vegetation Types per Dominant Shoreline Type of Northern Canal Vegetation Points (VPs)
Count
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4
4
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous


Dominant Vegetation Types per Dominant Shoreline Type of Pawtucket Canal
Vegetation Points (VPs)
Count
3.5
3
2.5
2
1.5
1
0.5
0
3
1
1
1
1
1
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous

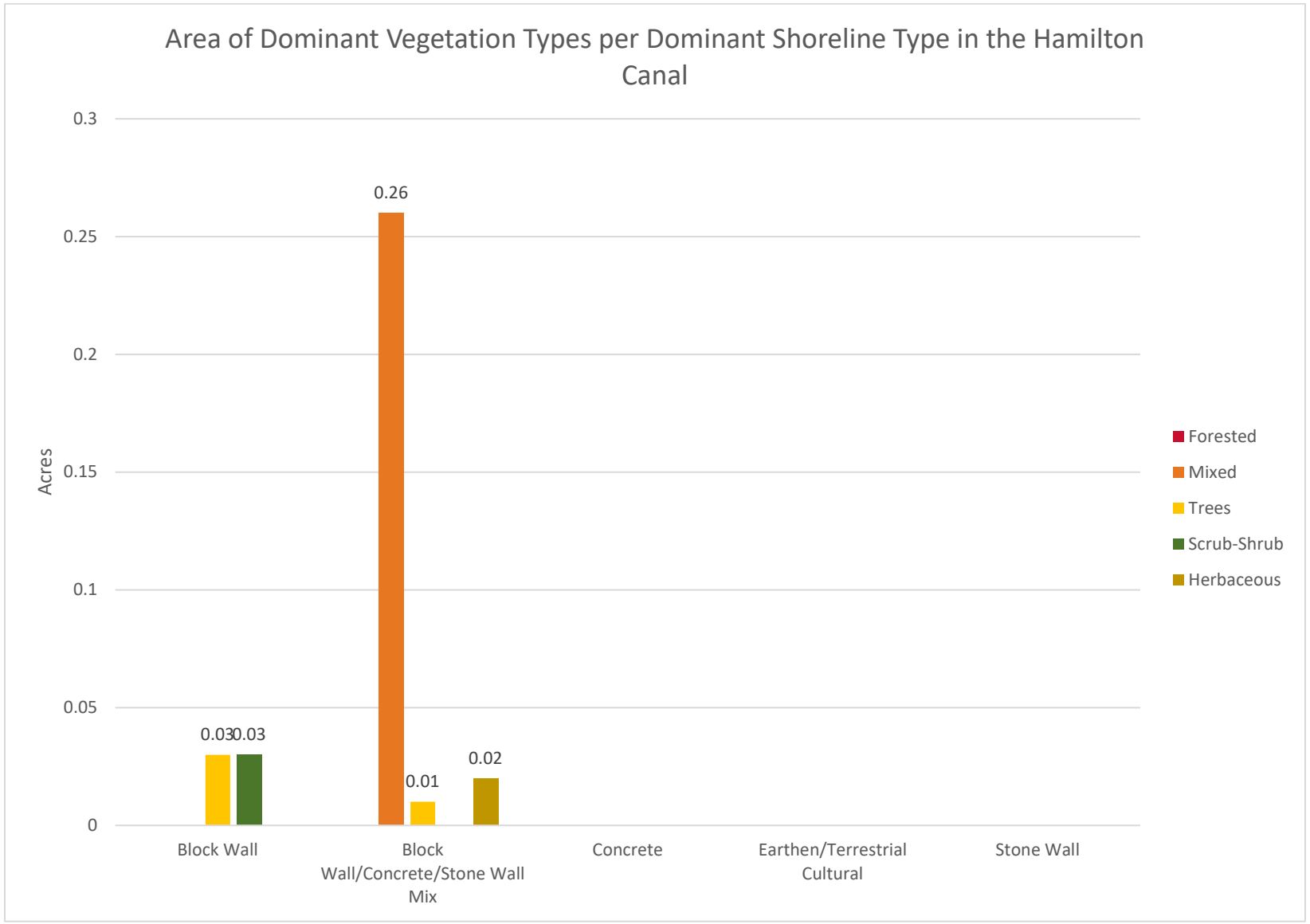

Dominant Vegetation Types per Dominant Shoreline Type of Western Canal
Vegetation Points (VPs)
1.2
1
0.8
0.6
0.4
0.2
0
Count
1
1
1
1
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Stone Wall
Mixed
Trees
Scrub-Shrub
Herbaceous



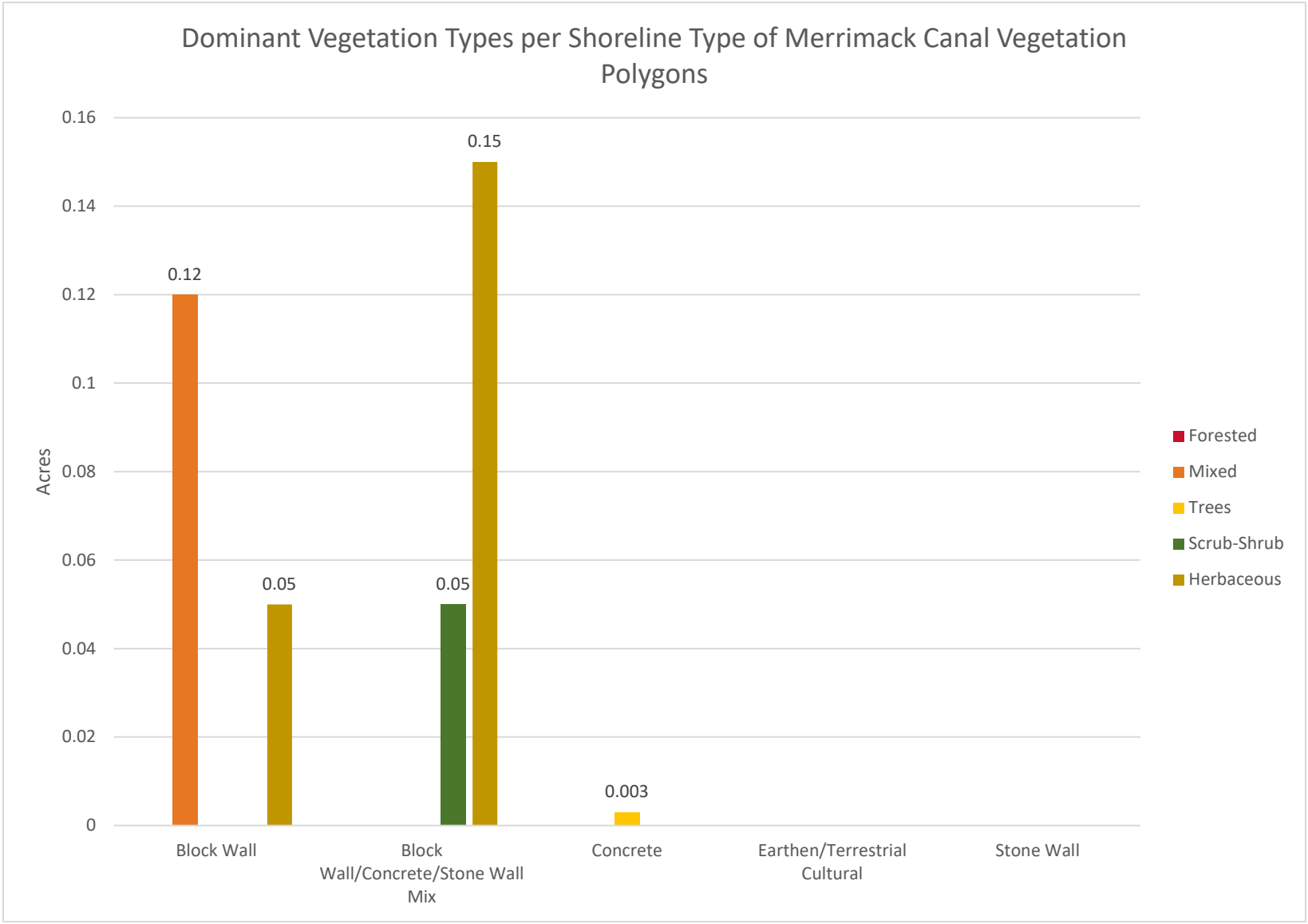
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



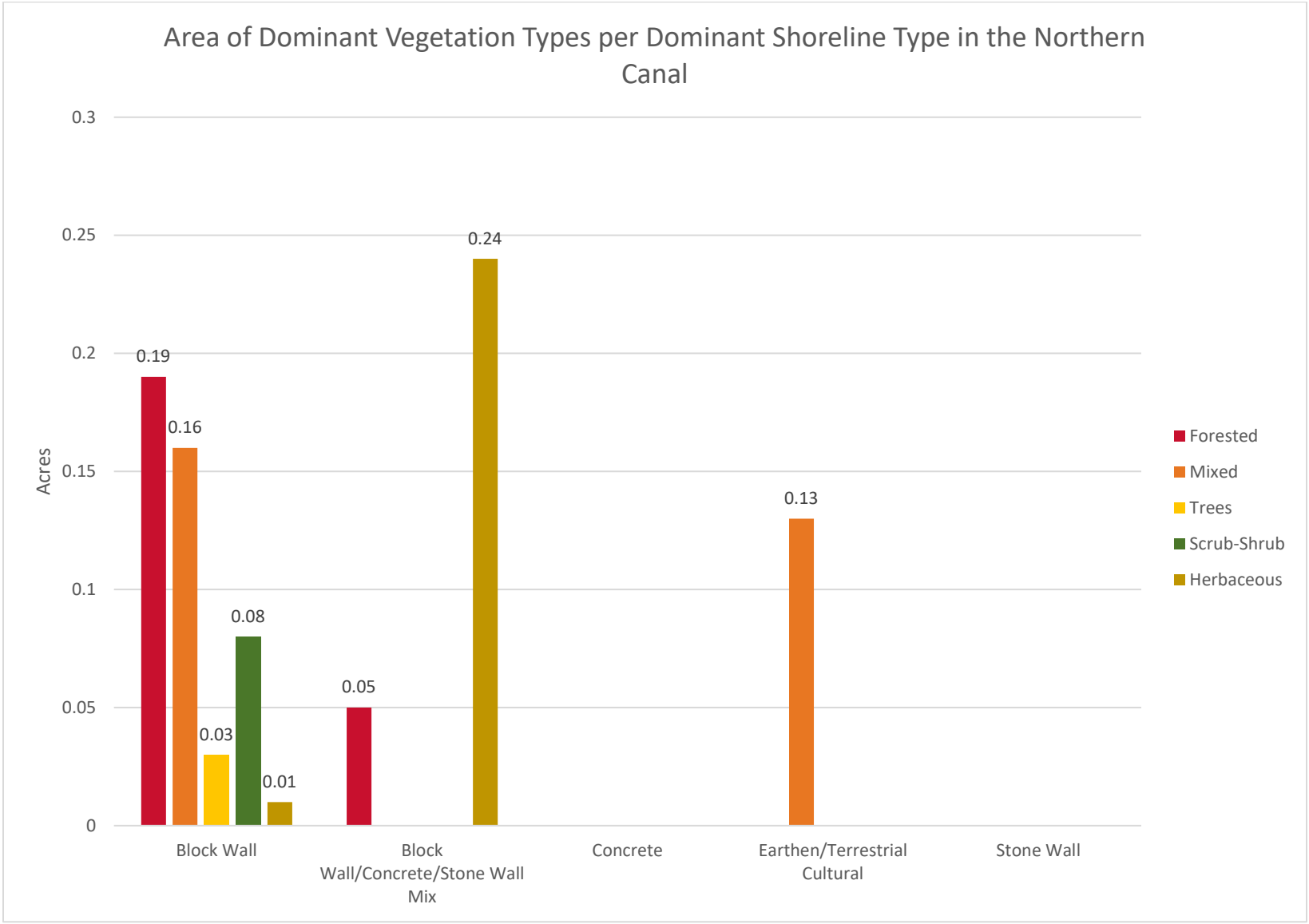
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



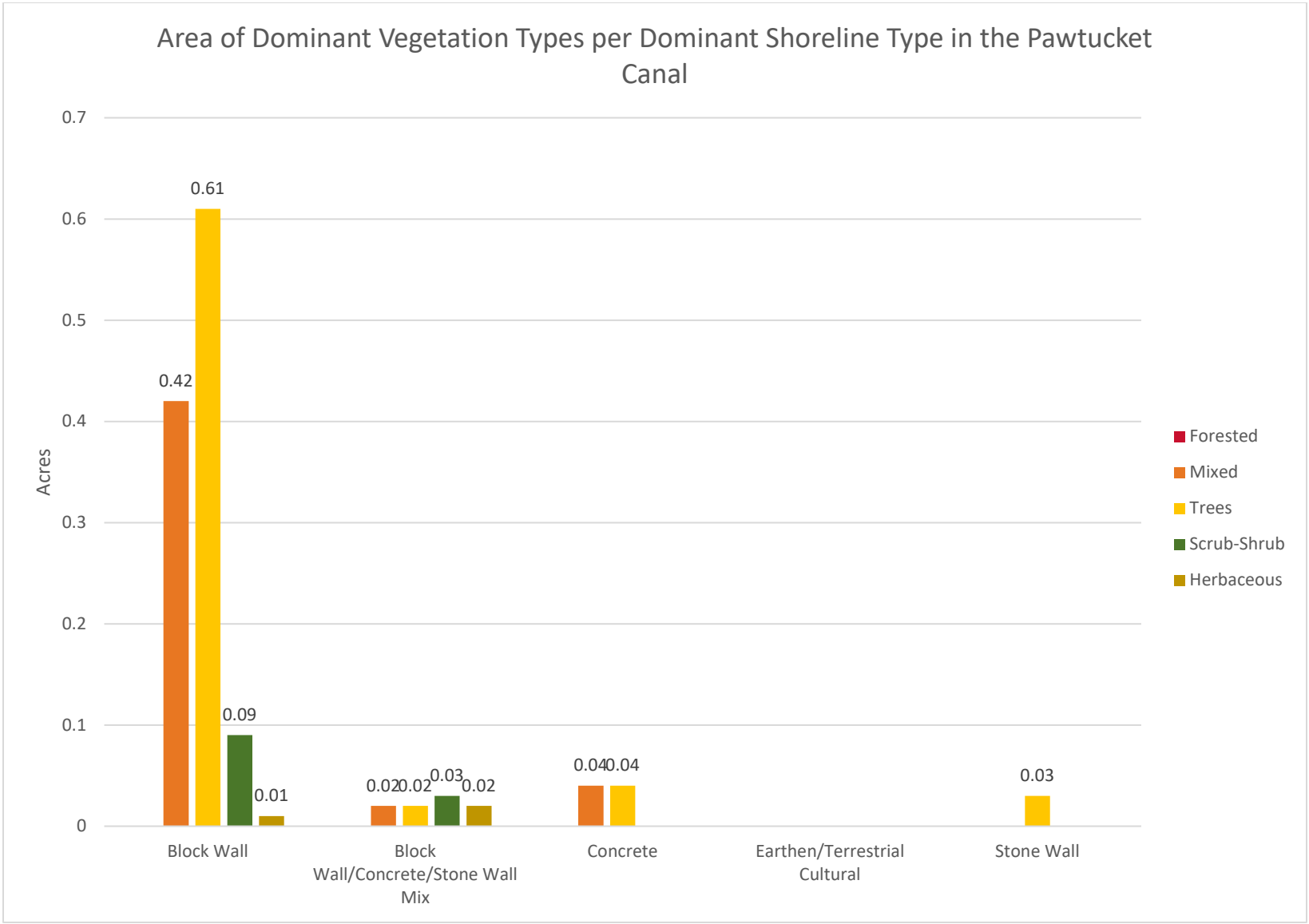
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations


Dominant Vegetation Types per Shoreline Type of Merrimack Canal Vegetation Polygons
Acres
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.12
0.05
0.05
0.15
0.003
Block Wall
Block Wall/Concrete/Stone Wall Mix
Concrete
Earthen/Terrestrial Cultural
Stone Wall
Forested
Mixed
Trees
Scrub-Shrub
Herbaceous

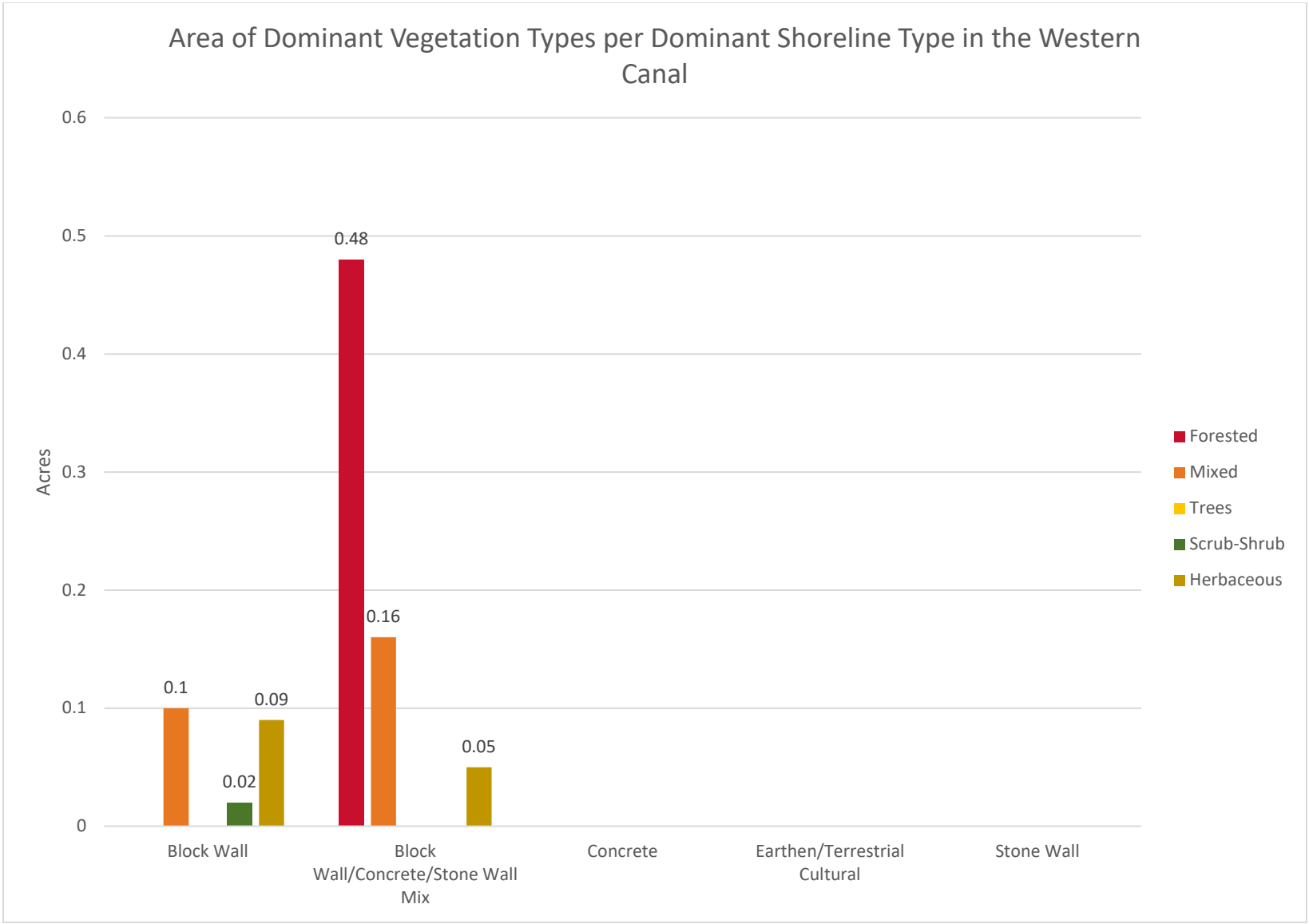
Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations



Note: Vegetation Points (VPs) are not included in mapped vegetation acreage calculations

Appendix J - Visual Survey for Vegetation Growth Representative Photographic Log

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 79
Photo No.: 79
Date: 9/27/2019
Direction Photo Taken: Northeasterly
Description: Tree of heaven trees and vines are growing on top of the canal wall and within approximately 3 feet of the canal wall.

Polygon No.: 78
Photo No.: 78
Date: 9/27/2019
Direction of Photo Taken: Westerly
Description: Vegetation growing out of the canal walls include tree of heaven and mulberry and herbaceous species such as purple loosestrife and mullein.

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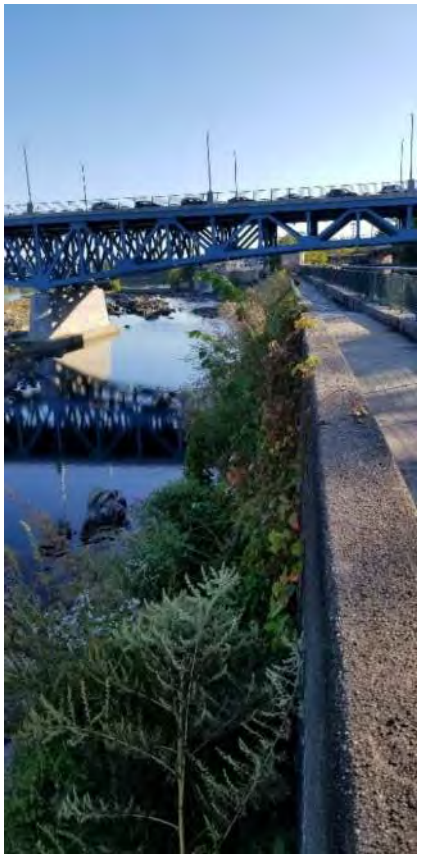
Canal Wall Vegetation Mapping Photo Log

Polygon No.: 92
Photo No.: P-9
Date: 9/27/2019
Direction Photo Taken: Southerly
Description: Vegetation growing on top of single stone/block wall on south side of the canal is forested habitat.

Polygon No.: 77
Photo No.: 77a
Date: 9/27/2019
Direction Photo Taken: Westerly
Description: At the western edge of the polygon, the canal broadens and is forested with riparian species. The topography extends to the bypass reach. Species include elms, mulberry, and honeysuckle. Some stumps have been cut along the canal wall on the same side as the bypass reach.

Canal Wall Vegetation Mapping Photo Log

Photo Location No.: P-6
Date: 9/26/2019
Direction Photo Taken: Easterly
Description: View of Pawtucket Gatehouse. Vegetation is growing on debris deposited against the gatehouse.



Polygon No.: 75
Photo No.: 75a
Date: 9/27/2019
Direction: Northeasterly
Description: Vegetation is growing from small sill under the first block down on the canal wall and is dominated by herbaceous plants such as ragweed, purple loosestrife, aster, scattered ferns, golden rod spp., scattered mulberry, elms, and buckthorn.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 74
Photo No.: 74
Date: 9/27/2019
Direction: Northeasterly
Description: Ragweed is growing out of the canal wall located beneath the building.

Polygon No.: 93
Photo Location No.: P-10
Date: 9/27/2019
Direction Photo Taken: Southerly
Description: Vegetation is growing on bedrock along south side of the canal.

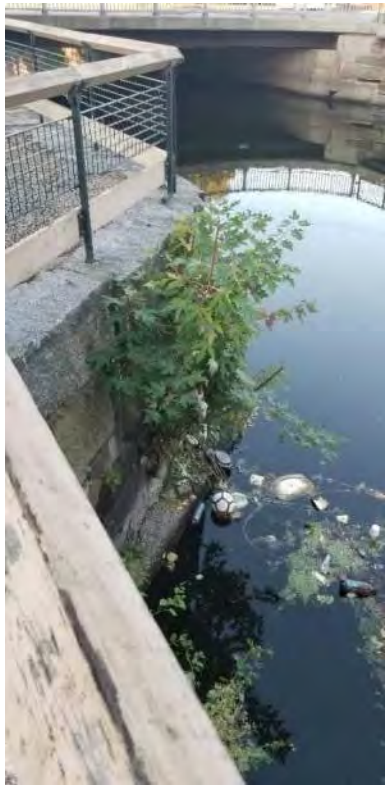
Canal Wall Vegetation Mapping Photo Log

Photo Location No.: P-7
Date: 9/26/2019
Direction Photo Taken: Northeasterly
Description: View from E.L. Field Powerhouse deck.

Polygon No.: 94
Photo Location No.: P-8
Date: 9/26/2019
Direction Photo Taken: Northerly
Description: View looking west toward E.L. Field Powerhouse from the NPS walking trail. Vegetation is growing on bedrock along south side of the canal.

Canal Wall Vegetation Mapping Photo Log

Vegetation Point No.: VP-10
Photo No.: VP-13
Date: 9/26/2019
Direction Photo Taken: Southerly
Description: A small maple is growing out of the canal wall, near the top of the wall.



Vegetation Point No.: VP-11
Photo No.: VP-14
Date: 9/26/2019
Direction Photo Taken: Southwesterly
Description: A small clump of silver maples are growing out of the canal wall.

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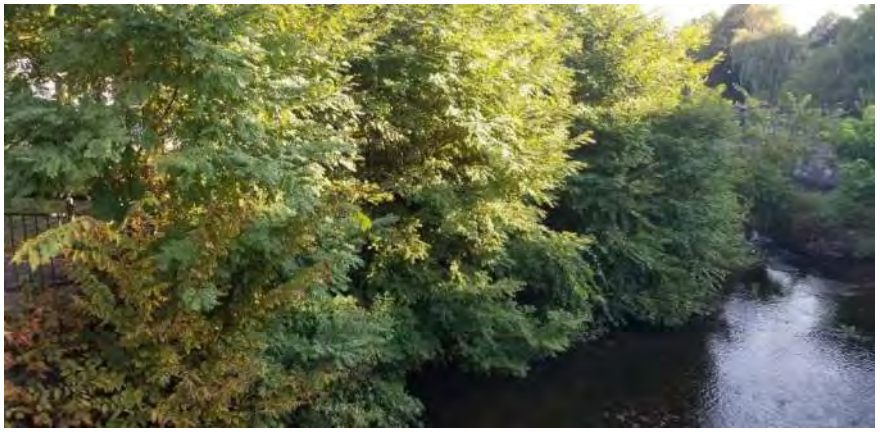
Canal Wall Vegetation Mapping Photo Log

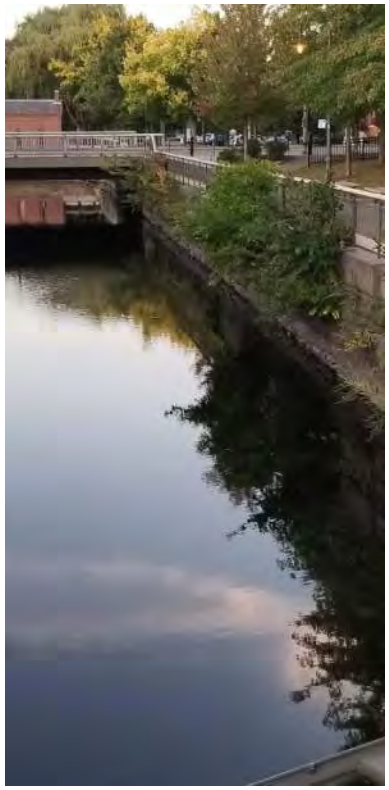
Polygon No.: 45 and 46
Photo No.: 45
Date: 9/26/2019
Direction Photo Taken: Northeasterly
Description: Vegetation growing on the eastern side of the canal wall (left side of the photograph) includes several tree species (i.e. mulberry, buckthorn, tree of heaven, etc.) and dense vines, including Boston ivy and poison ivy. Vegetation growing on the western side of the canal wall (right side of the photograph) includes less trees than the eastern side of the canal and similar vine species.



Polygon No.: 47
Photo No.: 47
Date: 9/26/2019
Direction Photo Taken: Northeasterly
Description: The vegetation growing on the canal wall includes large locust trees and ragweed.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 39
Photo No.: 39
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: A few small tree of heaven trees are growing out of the canal wall, near the top of the wall.



Polygon No.: 38
Photo No.: 38
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: Vegetation growing out of the canal wall, near the top of the wall consists of shrubs.

Canal Wall Vegetation Mapping Photo Log

Vegetation Point No.: VP-14
Photo No.: VP-17
Date: 9/26/2019
Direction Photo Taken: Southwesterly
Description: A small clump of shrubs growing out of the canal wall.

Polygon No.: 51
Photo No.: 51
Date: 9/26/2019
Direction Photo Taken: Northeasterly
Description: Vegetation growing on the canal wall include trees, such as mulberry and elms, and herbaceous ragweed.

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Canal Wall Vegetation Mapping Photo Log

Polygon No.: 54 and 55
Photo No.: 54
Date: 9/26/2019
Direction Photo Taken: Northerly
Description: Vegetation growing on the northern side of the canal wall (left side of the photograph) consists of primarily vines. Vegetation growing on the southern side of the canal wall (right side of the photograph) consists primarily of herbaceous vegetation, such as ragweed, and vines. A few tree of heaven trees are growing primarily at the toe of the canal wall on both sides of the canal; likely on deposited sediment, especially along the northern canal wall.

Polygon No.: 86
Photo No.: CV_Poly6
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: Vegetation growing on canal wall at the southwestern end of Polygon 86 is primarily herbaceous.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 86
Photo No.: CV_Poly6b
Date: 9/25/2019
Direction Photo Taken: Easterly
Description: The vegetation growing out of the canal includes tree of heaven and potentially milfoil and *Typha* spp.; other herbaceous species are growing at the bottom of the canal.

Polygon No.: 91
Photo No.: CV_Poly6a
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: The vegetation growing on the canal is primarily herbaceous; however, one maple at approximately 5-10 inches diameter at breast height is located approximately 2 feet back from the wall.

Recreation and Aesthetics Study Report

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Canal Wall Vegetation Mapping Photo Log

Polygon No.: 1
Photo No.: 1
Date: 9/25/2019
Direction Photo Taken: Northwesterly
Description: Several large woody trees are located at the northwestern end of the canal, including river birch growing on top of the canal wall. Herbaceous plants including ragweed and Boston ivy dominate the western side of the canal wall (left side of the photograph).

Polygon No.: 1
Photo No.: 1a
Date: 9/25/2019
Direction Photo Taken: Easterly
Description: Herbaceous plants including ragweed and Boston ivy dominate the western side of the canal wall (right side of the photograph).

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Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

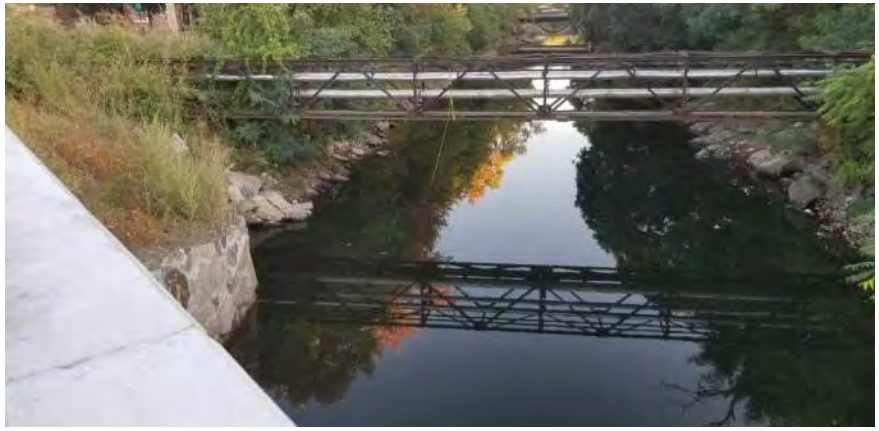


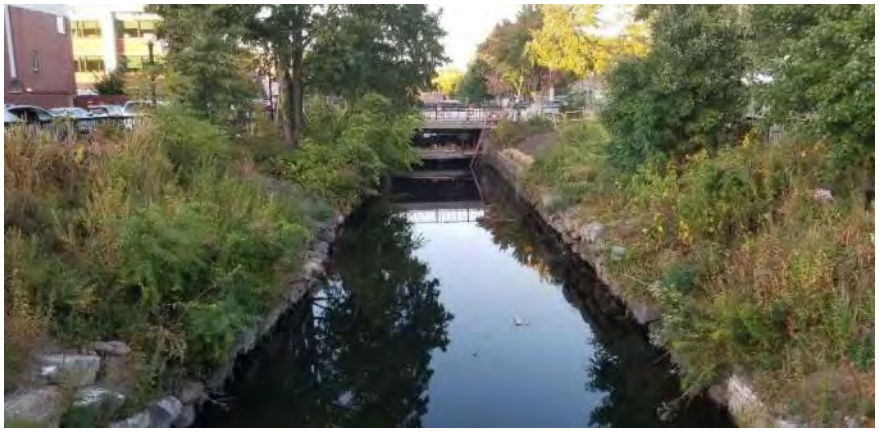
Photo Location No.: P-2
Date: 9/25/2019
Direction Photo Taken: Southwesterly
Description: Vegetation is growing on the riprap shoreline along both sides of the canal.

Photo Location No.: P-3
Date: 9/25/2019
Direction Photo Taken: Southwesterly
Description: Vegetation is growing on the riprap shoreline located on the eastern side of the canal (left side of the photograph). The western side of the canal wall (right side of the photograph) is concrete with little to no vegetation present.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log



Polygon No.: 34, 35, and 36
Photo No.: 34
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: The vegetation growing out of the eastern side of the canal wall (right side of the photograph) is sparse and consists primarily of vines. The vegetation growing on top of and approximately 3 feet back from the western side of the canal wall (left side of the photograph) is primarily herbaceous.

Polygon No.: 82
Photo No.: CV_Poly2
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: There is approximately 90 percent vegetative cover in this area; vegetation is mostly herbaceous, including ragweed, clover, *Aster* spp., and other common weeds. Two small tree of heaven trees are also present on the canal wall.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 84 and 85
Photo No.: CV_Poly4c
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: There is approximately 20 percent vegetative cover on the western side of the canal wall (right side of the photograph) located primarily one block down from the top of the wall; vegetation includes a few maples, honeysuckle, and scattered herbaceous species. There is approximately 40 percent vegetative cover on the eastern side of the canal wall (left side of the photograph); vegetation includes several elms, approximately 5 feet tall, several birches, and a few red maples.

Polygon No.: 3
Photo No.: 3
Date: 9/25/2019
Direction Photo Taken: Northwesterly
Description: The vegetation growing on the canal wall includes one elm tree, Boston ivy, and ragweed. Scattered submerged aquatic vegetation is growing in the canal.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Vegetation Point No.: VP-1
Photo No.: VP-4
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: Vegetation includes a single shrub growing out of the canal wall below the brick building and sparse herbaceous species.

Polygon No.: 89
Photo No.: CV_Poly9
Date: 9/25/2019
Direction Photo Taken: Southeasterly
Description: The vegetation growing out of the canal wall includes an approximately 10-trunked tree of heaven tree at approximately 6 inches diameter at breast height and poison ivy.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 90
Photo No.: CV_Poly10a
Date: 9/25/2019
Direction Photo Taken: Southwesterly
Description: The vegetation growing out of canal wall is a 3-trunked tree of heaven tree at approximately 4 inches diameter at breast height. A recently cut birch tree tied with rope was also observed along the canal wall.

Polygon No.: 4
Photo No.: 4
Date: 9/25/2019
Direction Photo Taken: Southerly
Description: There is one, multi-trunked tree of heaven tree at approximately 4 to 6 inches diameter at breast height growing out of the canal wall.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 70
Photo No.: 70
Date: 9/26/2019
Direction Photo Taken: Northwesterly
Description: The canal wall is primarily concrete with trees, such as locust and elm, growing at the toe of the wall.

Photo Location No.: P-4
Photo No.: P-15
Date: 9/26/2019
Direction Photo Taken: Easterly
Description: Dense vegetation is growing on earthen banks along the canal.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Photo Location No.: P-5
Photo No.: P-16
Date: 9/26/2019
Direction Photo Taken: Northwesterly
Description: Upstream view of dense vegetation growing on earthen banks along both sides of the canal.

Polygon No.: 41
Photo No.: 41b
Date: 9/25/2019
Direction Photo Taken: Southeasterly
Description: Portions of the canal wall at bridge crossings on each side of the canal are concrete and brick. The highest density of vegetation in the polygon consists of locust, tree of heaven, box elder, maples and scattered shrubs, some with approximately 6 to 14 inches diameter at breast height.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 13
Photo No.: 13
Date: 9/25/2019
Direction Photo Taken: Southerly
Description: There is one elm tree and one mulberry growing out of concrete portion of the canal wall.

Polygon No.: 16
Photo No.: 16
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: Approximately 20 percent of the canal wall has woody trees (i.e. elms, locust, and mulberry) or herbaceous plants growing on it.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 18
Photo No.: 18
Date: 9/25/2019
Direction Photo Taken: Southwesterly
Description: Approximately 20 percent of the canal wall has woody trees, shrubs, and/or herbaceous plants growing on it. The vegetation includes tree of heaven, maple, common mullein, Japanese knot weed, and ragweed. Japanese knot weed coverage increases with closer proximity to the National Park Service boat dock.

Polygon No.: 7
Photo No.: 7a
Date: 9/25/2019
Direction Photo Taken: Easterly
Description: Several large woody trees including river birch, tree of heaven, and silver maple, all approximately 2 to 5 inches diameter at breast height are growing out of the canal wall.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 8
Photo No.: 8
Date: 9/25/2019
Direction Photo Taken: Easterly
Description: The canal contains potential sediment deposited against the canal wall; the sediment is topped with a layer of herbaceous plants.

Vegetation Point No.: VP-4
Photo No.: VP-7
Date: 9/25/2019
Direction Photo Taken: Southeasterly
Description: A multi-trunked clump of trees, approximately 6 to 8 feet tall, are growing out of canal wall .

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 69
Photo No.: 69
Date: 9/26/2019
Direction Photo Taken: Northwesterly
Description: The trees growing out of canal wall include tree of heaven and elms at approximately 10 feet tall.

Polygon No.: 67
Photo No.: 67
Date: 9/26/2019
Direction Photo Taken: Northwesterly
Description: Large locust and birch trees are growing on top of the canal wall.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 66
Photo No.: 66a
Date: 9/26/2019
Direction Photo Taken: Northerly
Description: The vegetation growing out of the eastern side of the canal wall (right side of the photograph), at the top of the wall, includes trees, such as tree of heaven and birch, and vines, such as Boston ivy.

Vegetation Point No.: VP-16
Photo No.: VP-19
Date: 9/26/2019
Direction Photo Taken: Northerly
Description: A small clump of mulberry are growing out of the canal wall.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 56
Photo No.: 56
Date: 9/26/2019
Direction Photo Taken: Southwesterly
Description: Most of the canal wall is made of concrete with riprap placed at the toe of the wall. The vegetation growing on the canal wall consists of tree of heaven, box elder, and vines, such as Boston ivy.

Polygon No.: 57
Photo No.: 57
Date: 9/26/2019
Direction Photo Taken: Easterly
Description: Vegetation growing out of the canal wall includes ash trees at approximately 6 to 8 inches diameter at breast height.

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 23
Photo No.: 23
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: The vegetation on the canal wall is primarily tree of heaven and ragweed, with lesser density of mullein.

Polygon No.: 25
Photo No.: 25
Date: 9/25/2019
Direction Photo Taken: Northerly
Description: The vegetation growing out of the canal wall includes one sycamore, several tree of heaven, glossy buckhorn, and ragweed.

Recreation and Aesthetics Study Report

Lowell Hydroelectric Project (FERC No. 2790)

Canal Wall Vegetation Mapping Photo Log

Polygon No.: 26 and 27
Photo No.: 26
Date: 9/25/2019
Direction Photo Taken: Northeasterly
Description: The southern side of the canal wall (right side of the photograph), west of the walking bridge, consists of portions of concrete and is primarily covered in ragweed. Vegetation on the northern side of the canal wall (left side of the photograph) consists primarily of trees with approximately 10 percent cover. The northern side of the canal wall, west of the walking bridge, consists of portions of concrete.

Polygon No.: 26 and 27
Photo No.: 26a
Date: 9/25/2019
Direction Photo Taken: Southwesterly
Description: The southern side of the canal wall (left side of the photograph), east of the walking bridge, contains trees, such as tree of heaven and elm. Trees on the northern side of the canal wall (right side of the photograph), east of the walking bridge, are smaller and less dense than west of the walking bridge.

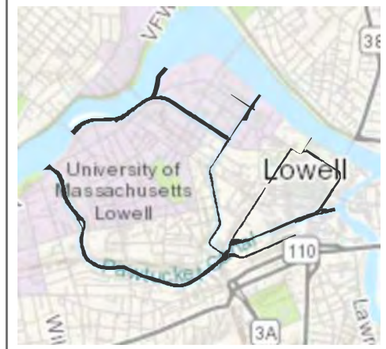
Canal Wall Vegetation Mapping Photo Log

Polygon No.: 58
Photo No.: 58b
Date: 9/26/2019
Direction Photo Taken: Southerly
Description: The vegetation growing out of the canal wall includes locust trees, tree of heaven trees, wild grape, and oriental bittersweet.

Appendix K - Visual Survey for Waterborne Trash Mapbook

Legend

- Project Facilities
- Canal System
- Canal Bed Trash
- Temporary Surface Sheen
- Waterborne Trash



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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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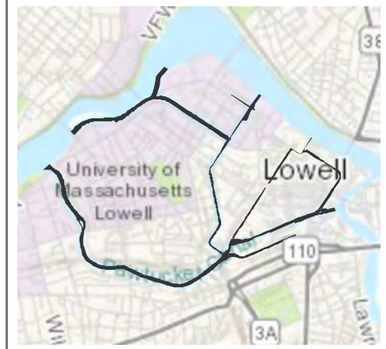
AUGUST 2020

Legend

- Project Facilities
- Canal System
- Canal Bed Trash
- Temporary Surface Sheen
- Waterborne Trash



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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
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AUGUST 2020

Legend

- Project Facilities
- Canal System
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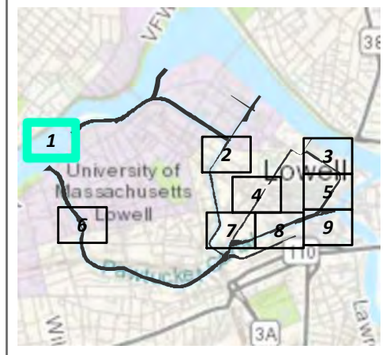
- Waterborne Trash



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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

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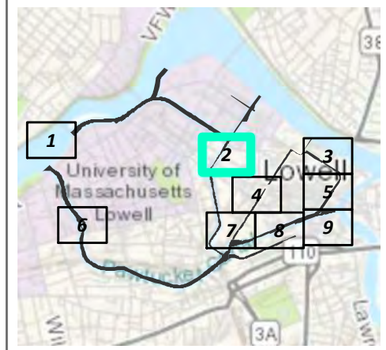

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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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AUGUST 2020

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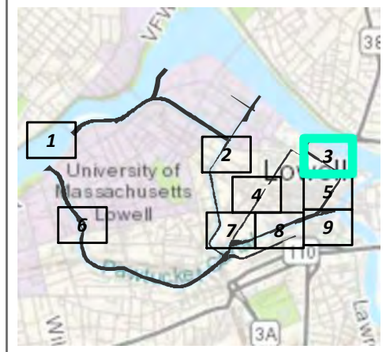

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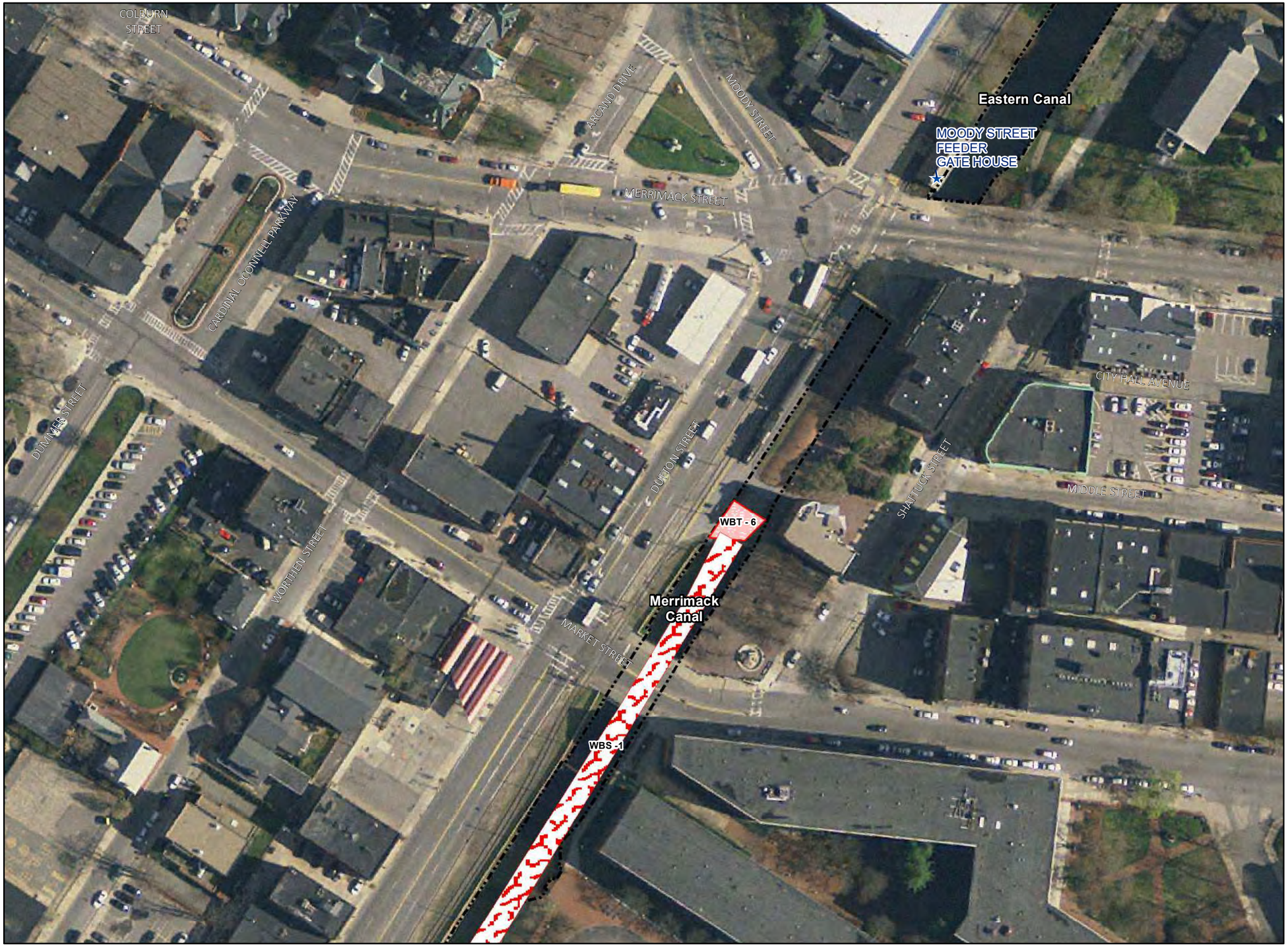

Legend

- Project Facilities
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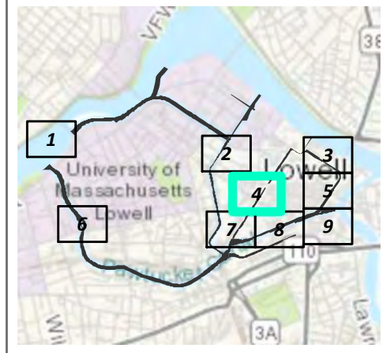
- Waterborne Trash



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Legend

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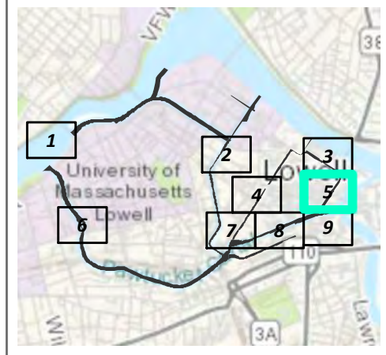
- Waterborne Trash



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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
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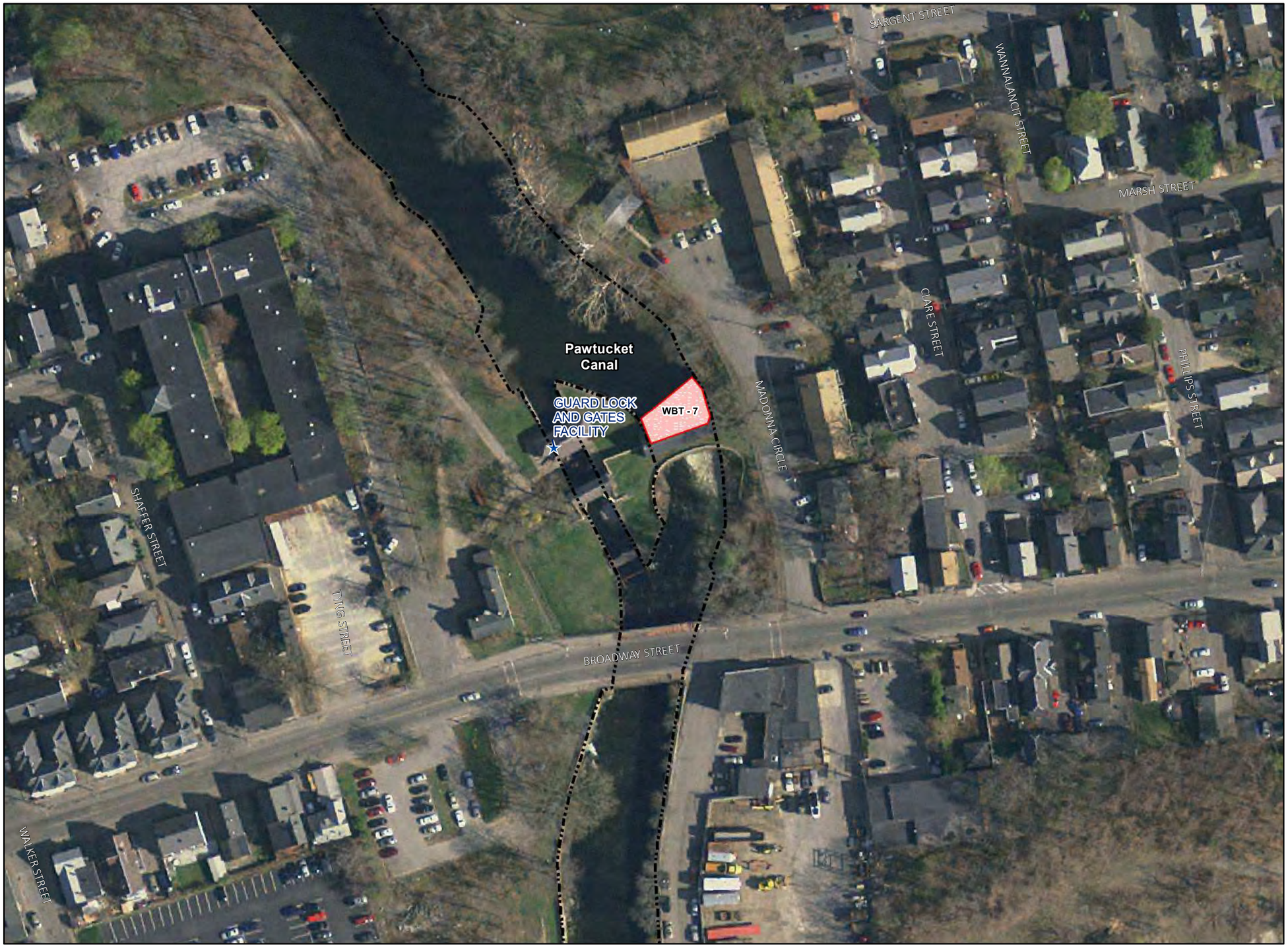
AUGUST 2020



Legend

- Project Facilities
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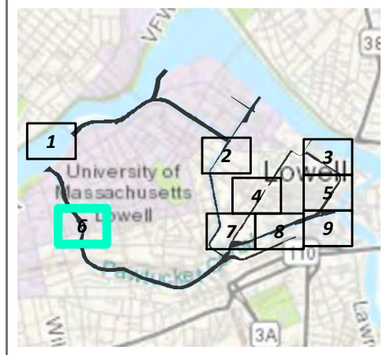
- Canal Bed Trash
- Temporary Surface Sheen
- Waterborne Trash



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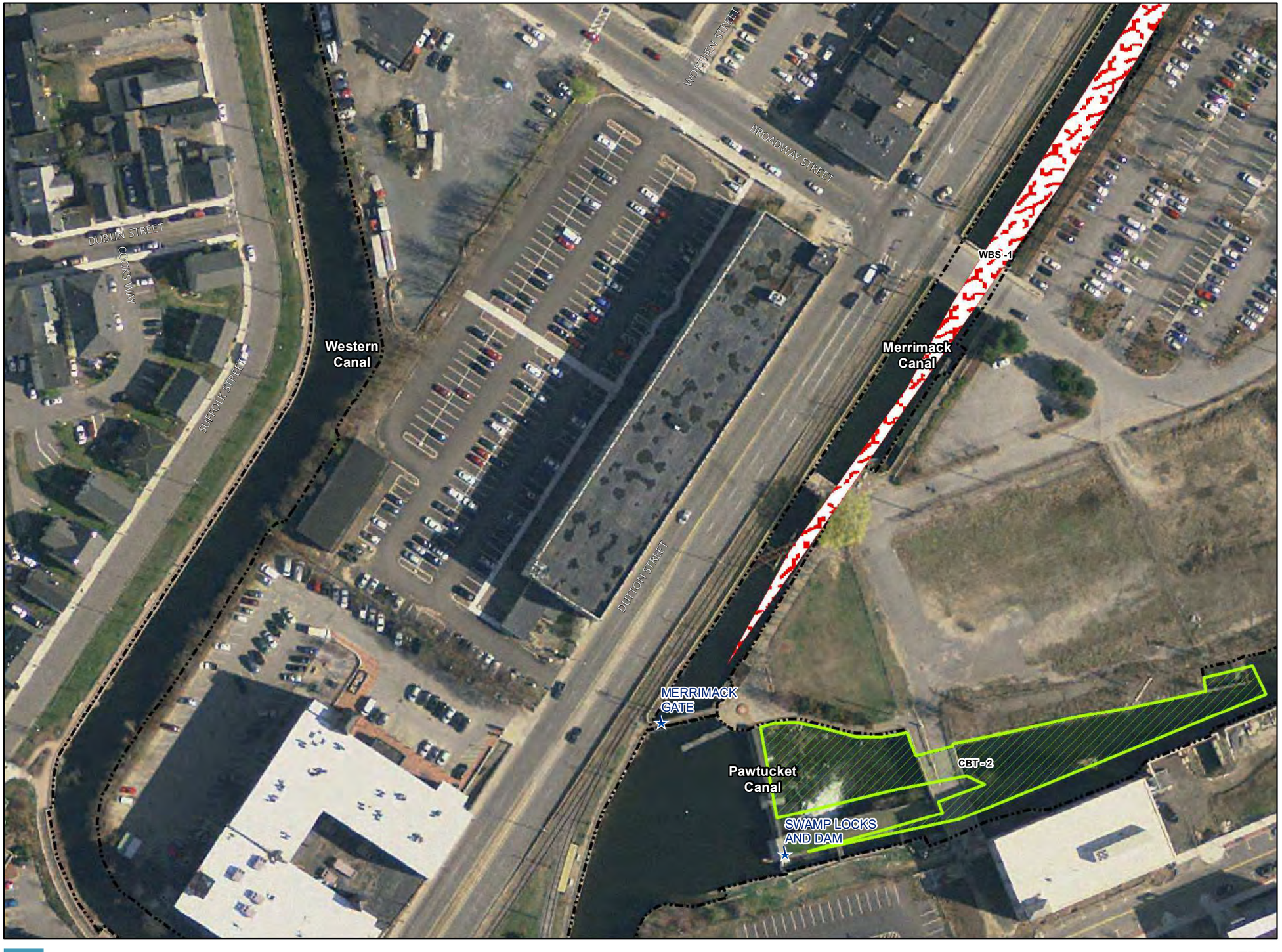

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Legend

- Project Facilities
- Canal System
- Canal Bed Trash
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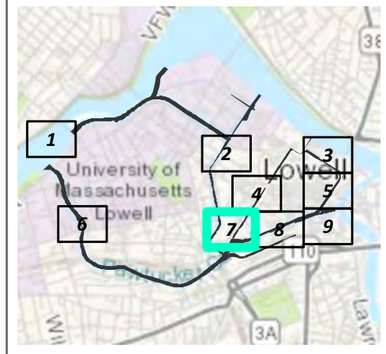
- Waterborne Trash



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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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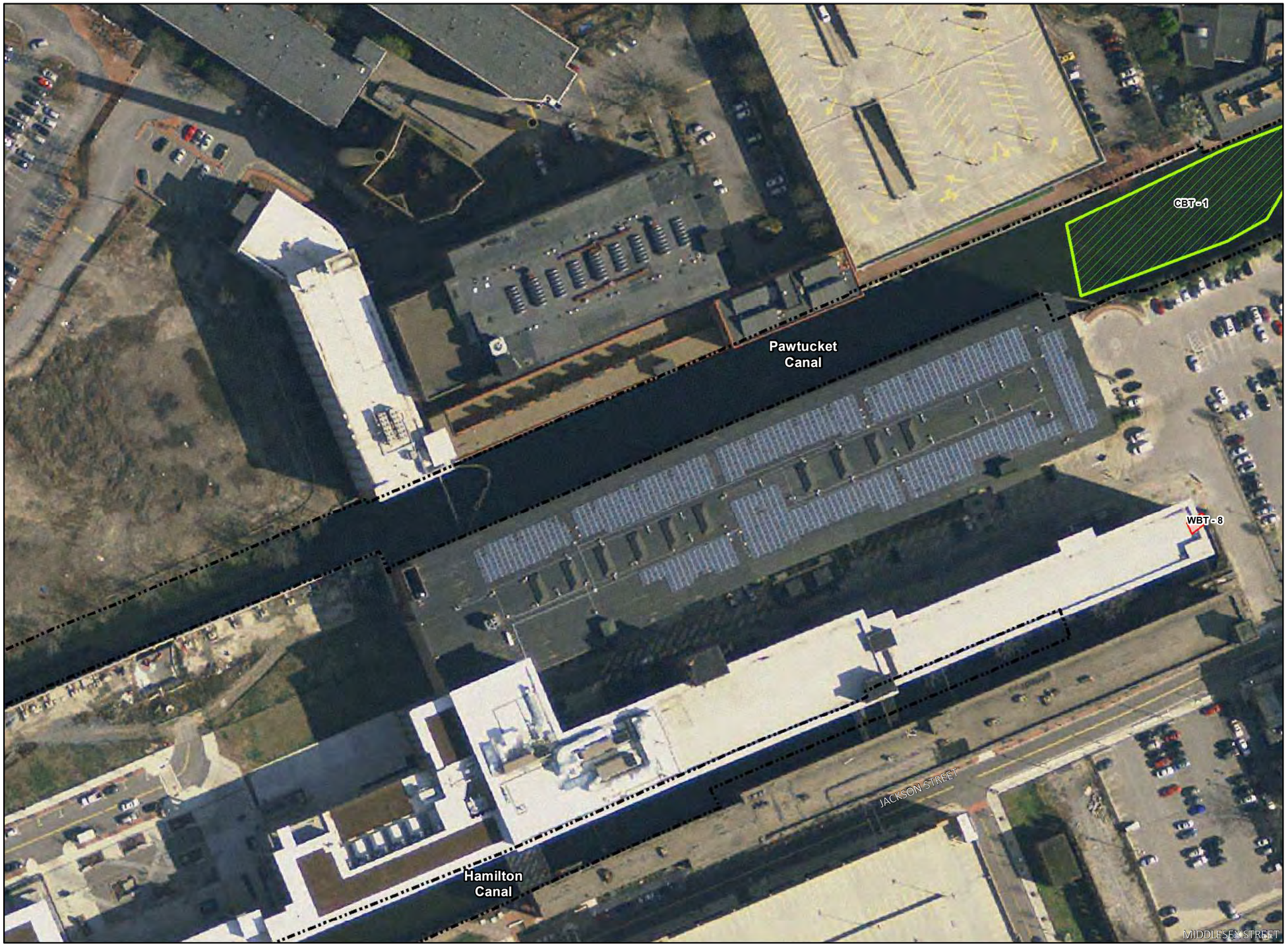
AUGUST 2020



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Legend

- Project Facilities
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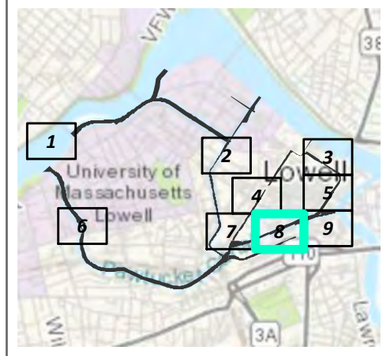

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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

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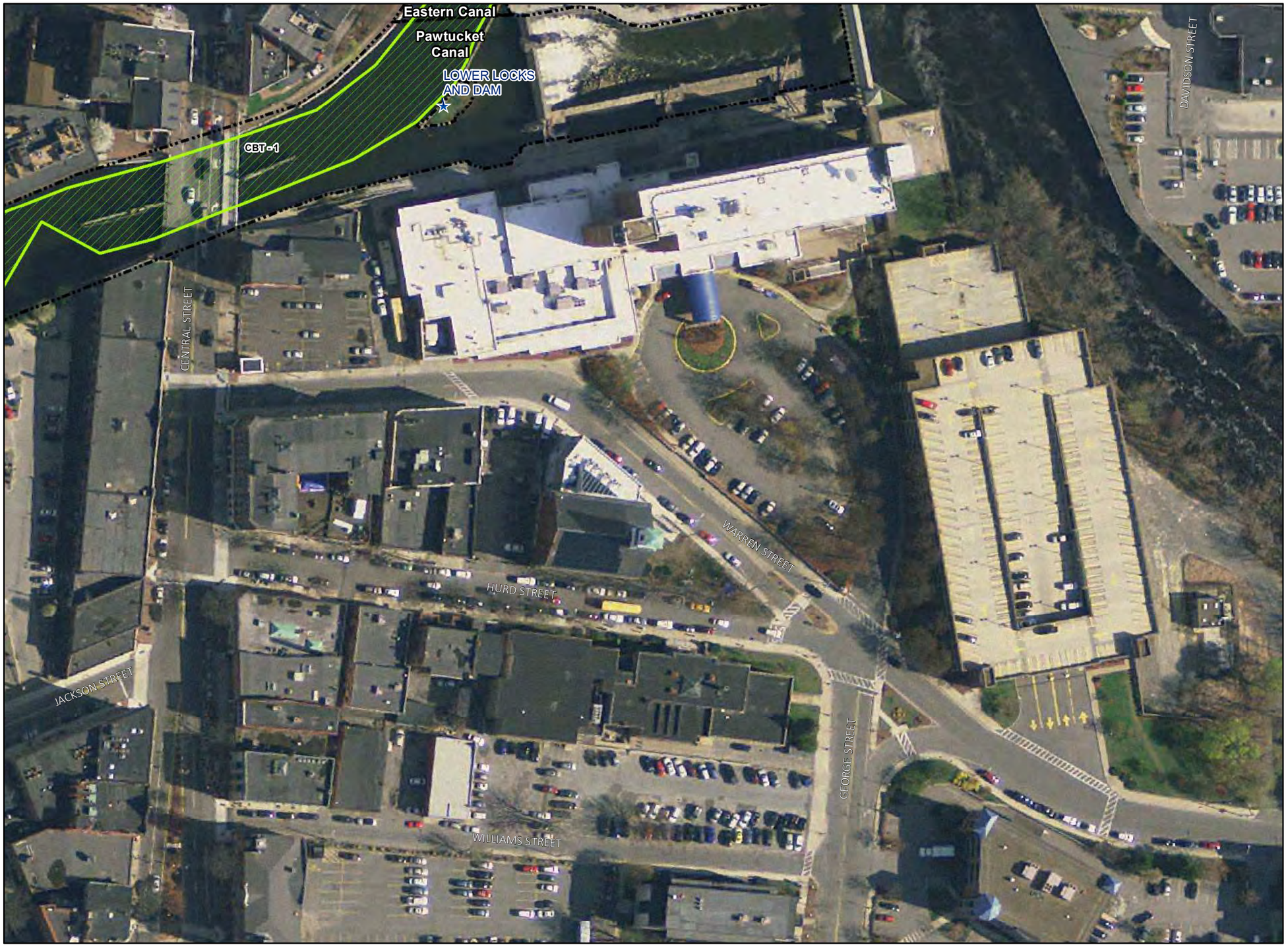
AUGUST 2020



Legend

- Project Facilities
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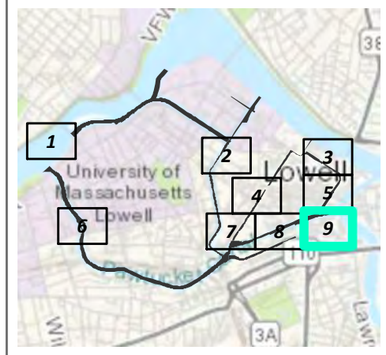

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BOOTT HYDRO, LLC.

TRASH ASSESSMENT AND MAPPING STUDY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790
AUGUST 2020

PATH: \\PIT-SRV05\GIS\NY\ENEL\10104574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\MAP_TRASHSTUDY11X17.MXD - USER: KAUSTIN - DATE: 9/11/2020

Appendix L - Correspondence and Consultation Log

Scott, Kelsey

From: Quiggle, Robert
Sent: Tuesday, May 7, 2019 2:08 PM
To: celeste_bernardo@nps.gov; Bob Nasdor (bob@americanwhitewater.org); Kevin.hollenbeck@state.ma.us
Cc: Kevin_mendik@nps.gov; 'Kevin.Webb@enel.com'; Anderson, Elise (EGP North America); Gibson, Jim; MacVane, Kelly; Scott, Kelsey
Subject: Lowell Hydroelectric Project (FERC No. 2790-072) -- Consultation Regarding the Recreation and Aesthetics Study
Attachments: 20190507 Lowell Hydro Project Recreation Study Consultation.pdf

Ms. Bernardo, Mr. Nasdor, and Mr. Hollenbeck:

On behalf of Boott Hydropower, LLC (Boott), I am distributing the attached consultation request in support of the Federal Energy Regulatory Commission (FERC) relicensing of the Lowell Hydroelectric Project (Project). As described in the attached correspondence, Boott is consulting with the National Park Service, American Whitewater, and the Massachusetts Department of Conservation and Recreation to identify locations in the Project's vicinity to conduct visitor intercept surveys of recreationists for the approved Recreation and Aesthetics Study.

Should you have any questions regarding the attached correspondence, please contact Kevin Webb with Boott at 978-935-6039 or Kevin.Webb@enel.com.

Thank you,

Robert Quiggle, RPA
Regulatory and Environmental Section Manager

HDR
1304 Buckley Road, Suite 202
Syracuse, New York 13212-4311
D 315.414.2216 **M** 724.989.1579
Robert.Quiggle@hdrinc.com

hdrinc.com/follow-us

Boott Hydropower, LLC
A Subsidiary of Enel Green Power North America, Inc.

100 Brickstone Square, Suite 300 – Andover, MA 01810 – USA
T +1 978 681 1900 – F +1 978 681 7727

Via Electronic Distribution

May 7, 2019

Celeste Bernardo
Superintendent of Lowell National Historical Park
National Park Service
67 Kirk Street
Lowell, MA 01852

Robert Nasdor
NE Stewardship Director
American Whitewater
65 Blueberry Hill Lane
Sudbury, MA 01776

Kevin Hollenbeck
Metrowest District Manager
DCR Great Brook Farm State Park
984 Lowell Street
Carlisle, MA 01741

Re: Lowell Hydroelectric Project (FERC No. 2790-072);
Consultation Regarding the Recreation and Aesthetics Study

Dear Stakeholders:

Boott Hydropower, LLC (Boott), a subsidiary of Enel Green Power North America, Inc. (Enel), is the Licensee and operator of the 22.4 megawatt (MW) Lowell Hydroelectric Project (Project or Lowell Project). The Lowell Project is located on the Merrimack River in Middlesex County, Massachusetts, and in Hillsborough County, New Hampshire. The existing license for the Project was issued by the Federal Energy Regulatory Commission (FERC or Commission) with an effective date of May 1, 1973. The existing license expires on April 30, 2023. Accordingly, Boott is pursuing a new license for the Project pursuant to the Commission's Integrated Licensing Process (ILP), as described at 18 Code of Federal Regulations (CFR) Part 5.

In accordance with the Commission's Study Plan Determination issued on March 13, 2019, Boott is initiating consultation with the National Park Service (NPS), American Whitewater, and the Massachusetts Department of Conservation and Recreation (MADCR) to identify specific locations for field reconnaissance and visitor-intercept surveys. As part of the Recreation and Aesthetics Study, Boott will conduct field reconnaissance and visitor-intercept interviews at specific recreational facilities during the prime recreational season from May 2019 through October 2019. Boott will interview recreationists visiting these locations to collect data relevant to visitors' recreational experience in the Project area, including but not limited to, data regarding demographics, types of recreational activities participated in or may participate in during their visit, and their reasons for choosing the site or area. As a separate component of the Recreation and Aesthetics Study, Boott is hosting an online version of the visitor-intercept survey to capture additional recreationists that would like to participate (the online version of the visitor survey is available at: https://hdrinc.co1.qualtrics.com/jfe/form/SV_0AnPxTboxMRT8nX). Boott will install signage informing recreationists of the online survey at various locations determined in consultation with NPS.
As shown in Figure 1 provided as Attachment A, Boott is proposing the following nine locations to conduct the reconnaissance and visitor-intercept surveys:

- Lowell Heritage State Park
- Merrimack Trail System

- Pawtucket Falls Overlook
- NPS Canal Walkways
- Lowell National Historic Park
- Lowell National Historic Park Visitor Center
- Chelmsford Boat Access
- Rourke Brothers Boat Ramp
- Merrill Park

Boott is also proposing ten locations[1] (as shown in Figure 1) to install the temporary signs informing recreationists of the online survey opportunity. Boott respectfully requests any comments regarding the proposed reconnaissance and visitor-intercept locations or the signage locations within 15 days of this letter (i.e., by May 22, 2019). Following consultation with stakeholders, Boott will develop the final list of reconnaissance and visitor-intercept locations and will file the final list with the Commission and distribute to American Whitewater, NPS, and the MADCR. If we do not receive a response from your office, Boott will move forward with the study to include the visitor-intercept survey locations as shown in the attached figure.

On behalf of Boott, I appreciate the opportunity to consult with your offices regarding this study. Please do not hesitate to contact me at (978) 935-6039 if you have any questions concerning this matter.

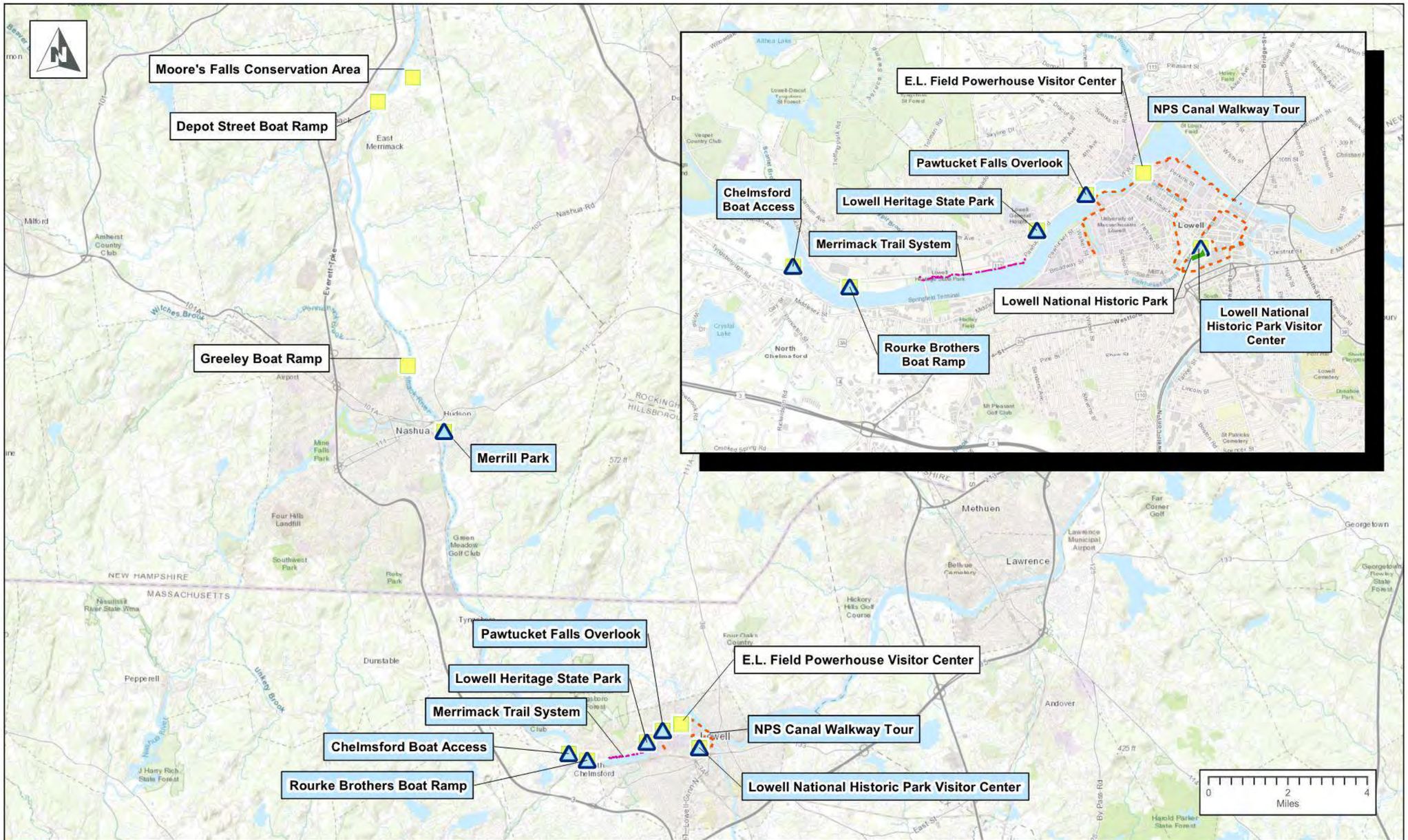
Sincerely,
Boott Hydropower, LLC

Kevin M. Webb
Hydro Licensing Manager

cc: K. Bose, FERC
K. Mendik, NPS

Attachment A – Figure 1

[1]Boott will install temporary signs that will be removed at the completion of the study season. Boott will not affix signage to any historic structures or cultural resources without additional prior consultation with NPS and NPS partners.



BOOTT HYDRO, LLC.

Recreation Survey Location | Proposed Signage Location | Merrimack River Trail | NPS Canal Walkway Tour

RECREATION SURVEY
LOWELL HYDROELECTRIC PROJECT
FERC NO. 2790

PATH: \\PIT-SRV05\GIS\NY\ENEL\10194574_ENEL_LOWELL_STUDIES\MAP_DOCS\DRAFT\COPY_OF_MAP_RECREATIONSURVEY_9SITES.MXD - USER: KAUSTIN - DATE: 5/7/2019

MAY 2019

AMERICAN WHITEWATER

Robert A. Nasdor
Northeast Stewardship & Legal Director
365 Boston Post Road, Suite 250
Sudbury, MA 01776
617-584-4566
bob@americanwhitewater.org

www.americanwhitewater.org

May 17, 2019

Kevin Webb
Enel Green Power
100 Brickstone Square, Suite 300
Andover, MA 01810

Dear Kevin,

I write in response to your letter of May 7, 2019 regarding the proposed locations for field reconnaissance user intercept surveys for the Lowell Hydroelectic Project Recreation and Aesthetics Study. Thank you for reaching out to us to solicit our feedback in accordance with the requirements of the Study Plan Determination.

While the proposed locations will provide useful information to better understand aspects of current and future recreational use in the project area, these proposed locations will not collect information that will enable the Licensee and FERC to evaluate recreational demand for flows, access, and facilities that would support whitewater boating opportunity in the bypassed reach or in other areas that are impacted by project operations. There is well established history of whitewater boating on the Concord River during the spring freshet, demonstrating that there is strong interest in whitewater boating opportunity in the project area. Given the current lack of flows, access and information that would provide for whitewater boating opportunity in the bypassed reach, we do not believe that the survey locations will adequately collect information that will be useful for determining future whitewater boating use.

We recommend that the Licensee utilize the online survey instrument to collect information from whitewater boaters to evaluate the demand for whitewater boating opportunity at the project. In addition, the Licensee should incorporate into this study the results of the planned whitewater boating study that will evaluate the suitability of the bypassed reach for whitewater boating. We also recommend that the licensee collect user intercept surveys at the whitewater takeout on the Merrimack River below the confluence with the Concord River during weekends during the spring freshet in 2020 in order to include information from whitewater boaters in this study.

Thank you for considering this information in the development of the survey plan.

We look forward to working with you throughout the relicensing process.

Very truly yours,

Bob Nasdor
Northeast & Legal Stewardship Director
365 Boston Post Road, Suite 250
Sudbury, MA 01776
617-584-4566
bob@americanwhitewater.org

Scott, Kelsey

To: Jones, Scott
Subject: RE: [EXTERNAL] Lowell Project Recreation and Aesthetics Study

From: Bruins, Christine [mailto:christine_bruins@nps.gov]
Sent: Friday, June 14, 2019 10:15 AM
To: Jones, Scott <Scott.Jones@hdrinc.com>
Cc: Quiggle, Robert <Robert.Quiggle@hdrinc.com>; Webb, Kevin (EGP North America) <Kevin.Webb@enel.com>
Subject: Re: [EXTERNAL] Lowell Project Recreation and Aesthetics Study

Scott,

The City of Lowell is carrying out a number of bridge construction project this year and the crew is experiencing issues controlling water. There is a moderate probability the entire canal system will be drained down next week to diagnose and resolve the problem. City is being fined thousands of dollars daily while work cannot not resume and the water control issue cannot be delayed. Is there any chance you could rework your schedule for the following week?

Christine Bruins | Community Planner
Lowell National Historical Park
978.275.1726 (office) | 978.954.1011 (cell)

On Fri, Jun 14, 2019 at 7:52 AM Jones, Scott <Scott.Jones@hdrinc.com> wrote:

> Christine,
>
> Right now we are scheduled for Tuesday (6/18) as I am also scheduled to be on another project on Wednesday and Thursday of that week. This other work is flow and weather dependent so if anything changes I will certainly let you know. Thanks for the update.
>
> Regards,
>
> **Scott A. Jones, B.S., PWS**
>
> Senior Environmental Scientist/Project Manager
>
> **D** 315.414.2205 **M** 315.317.6680
>
> scott.jones@hdrinc.com
>
> hdrinc.com/follow-us

From: Bruins, Christine [mailto:christine_bruins@nps.gov]
Sent: Thursday, June 13, 2019 11:54 AM
To: Jones, Scott <Scott.Jones@hdrinc.com>
Cc: Quiggle, Robert <Robert.Quiggle@hdrinc.com>; Webb, Kevin (EGP North America) <Kevin.Webb@enel.com>
Subject: Re: [EXTERNAL] Lowell Project Recreation and Aesthetics Study

Scott,

Now that the Eastern Canal is drained for bridge work, there is a lot of trash visible on the canal bottom. This includes electronics and other hazardous items. Our staff are in a required 2-day occupational hazard training Tuesday and Wednesday next week. Would it at all be possible to meet in the field with you Thursday instead?

Christine Bruins | Community Planner

Lowell National Historical Park

978.275.1726 (office) | 978.954.1011 (cell)

On Wed, Jun 12, 2019 at 2:47 PM Bruins, Christine <christine_bruins@nps.gov> wrote:

> We can arrange to take you by trolley/boat to efficiently get you to and around most of the canal areas.
>
> **Christine Bruins | Community Planner**
>
> Lowell National Historical Park
>
> 978.275.1726 (office) | 978.954.1011 (cell)
>
> On Wed, Jun 12, 2019 at 2:44 PM Jones, Scott <Scott.Jones@hdrinc.com> wrote:

Christine,

Thank you for following up with us. I received your message but have been tied up this afternoon. I am still solidifying my plans for next week, but we envision either Tuesday or Wednesday and can certainly meet you/staff/partners during one of those afternoons. I should know for sure by the end of this week. Thank you also for the detailed map, it will certainly make our visit more efficient. I will let you know as soon as I confirm my schedule. Thanks again,

Scott A. Jones, B.S., PWS

Senior Environmental Scientist/Project Manager

D 315.414.2205 **M** 315.317.6680

scott.jones@hdrinc.com

hdrinc.com/follow-us

From: Bruins, Christine [mailto:christine_bruins@nps.gov]
Sent: Wednesday, June 12, 2019 2:34 PM
To: Webb, Kevin (EGP North America) <Kevin.Webb@enel.com>
Cc: Jones, Scott <Scott.Jones@hdrinc.com>; Quiggle, Robert <Robert.Quiggle@hdrinc.com>
Subject: Re: [EXTERNAL] Lowell Project Recreation and Aesthetics Study

Scott,

Celeste asked me to coordinate your trash survey next week with our staff and partners. I have gathered information from our staff on the areas where trash collects (see attached map). I am very interested in meeting with you to discuss the issues and problem areas. I'd also be interested in accompanying you and others for part of your field work. I'm collecting the availability of other staff and partners that would like to be involved in the study. Have you narrowed your field work within next week? My availability next week is as follows, will update you when I hear back from a couple of others.

Mon 6/17 - After 2 pm

Tue 6/18 - after 12 pm

Wed 6/19 before 2 pm

Thurs - anytime

Fri - anytime

Christine Bruins | Community Planner

Lowell National Historical Park

978.275.1726 (office) | 978.954.1011 (cell)

On Tue, Jun 4, 2019 at 10:35 AM Bernardo, Celeste <celeste_bernardo@nps.gov> wrote:

> Christine, in my absence, are you okay with coordinating with ENEL on this? I am fine with them attending a management team or biweekly meeting, although biweekly would be better since there are more supervisors. Or else you can set up a separate meeting. Can you check with Paul and Kevin and see who on their staffs should participate?
>
> Celeste
>
> Celeste Bernardo
>
> Superintendent
>
> Lowell National Historical Park
>
> 978 275-1703
>
> celeste_bernardo@nps.gov
>
> Like us on Facebook
>
> ---------- Forwarded message ---------
> From: **Jones, Scott** <Scott.Jones@hdrinc.com>
> Date: Mon, Jun 3, 2019 at 2:50 PM

Subject: [EXTERNAL] Lowell Project Recreation and Aesthetics Study
To: Bernardo, Celeste <celeste_bernardo@nps.gov>
Cc: Kevin.Webb@enel.com <Kevin.Webb@enel.com>, Quiggle, Robert <Robert.Quiggle@hdrinc.com>

Celeste,

As part of the Lowell Recreation and Aesthetics Study, HDR is planning on visiting the Project the week of June 17-21, 2019 to survey and document waterborne trash as outlined in the study plan approved by the Federal Energy Regulatory Commission. In accordance with the approved plan, HDR is conducting this work in the spring of 2019 when higher flows typically push trash and debris downstream. Based on our meeting last week, HDR understands that NPS staff is very familiar with locations within the canal system where waterborne trash accumulates. In anticipation of our visit, HDR would like to coordinate with your office to identify these areas so that we can accurately document and record these locations.

Accordingly, we are hoping to meet with you or your staff to briefly review project maps prior to the start of fieldwork. If you could let me know a good time during the week of June 17 to meet with you or appropriate NPS staff, it would be greatly appreciated. Please note that NPS staff is also welcome to accompany us as we conduct this fieldwork (we expect the work to take about a day to complete).

Thank you,

Scott A. Jones, B.S., PWS

Senior Environmental Scientist/Project Manager

HDR

1304 Buckley Road, Suite 202
Syracuse, NY 13212
D 315.414.2205 **M** 315.317.6680
scott.jones@hdrinc.com

hdrinc.com/follow-us

Scott, Kelsey

From: Bernardo, Celeste <celeste_bernardo@nps.gov>
Sent: Wednesday, July 3, 2019 8:25 AM
To: Jones, Scott
Cc: Kevin.Webb@enel.com; Quiggle, Robert
Subject: Re: [EXTERNAL] Lowell Project Recreation and Aesthetics Study

That's great Scott. Thank you for the clarification. Look forward to assisting where we can.

Celeste

Celeste Bernardo
Superintendent
Lowell National Historical Park
978 275-1703
celeste_bernardo@nps.gov
Like us on Facebook

On Tue, Jul 2, 2019 at 7:48 PM Jones, Scott <Scott.Jones@hdrinc.com> wrote:

> Celeste,
> As the RSP and the FERC SPD indicates we will be surveying for water-borne trash after spring freshet, so with the unusual conditions this year we will be performing this component in 2020. Tomorrow we will be downloading the level loggers and installing recreational survey signs. Call or email me if you or Christine have any questions.
>
> Sent via the Samsung Galaxy S9+, an AT&T 5G Evolution capable smartphone

Scott, Kelsey

From: Scott, Kelsey
Sent: Friday, November 1, 2019 2:24 PM
To: celeste_bernardo@nps.gov; christine_bruins@nps.gov; Paul_Fontaine@nps.gov; kevin_coffee@nps.gov; laurel_racine@nps.gov; peter_reitchel@nps.gov; kevin_mendik@nps.gov; duncan_hay@nps.gov; Emily.Byrne@mail.house.gov; darryl.forgione@mass.gov; patrice.kish@mass.gov; thomas.m.walsh@mass.gov; william.cooksey@mass.gov; peter.hoffmann@mass.gov; dtradd@lowellma.gov; KKeefeMullin@lowellma.gov; cthomas@lowellma.gov; cclancy@lowellma.gov; jwinward@lowellma.gov; CRicker@lowellma.gov; chayes@lowellma.gov; CMcCall@lowellma.gov; scerand@hotmail.com; greenesh@comcast.net; jcalvin@lowelllandtrust.org; ffaust@edgegroupinc.com
Cc: Quiggle, Robert; Webb, Kevin (EGP North America); elise.anderson@enel.com
Subject: Lowell Hydroelectric Project (FERC No. 2790) Study Workshop
Attachments: November 2019_Lowell Hydro Project Workshop Agenda.pdf

Dear Stakeholders:

Boott Hydropower, LLC (Boott) is pursuing a new license from the Federal Energy Regulatory Commission (FERC) for the continued operation of the Lowell Hydroelectric Project (FERC No. 2790)(Project) located along the Merrimack River. In support of Project relicensing, Boott is conducting a Recreation and Aesthetics Study, a Historically Significant Waterpower Equipment Study, and a Water Level and Flow Effects on Historic Resources Study, as approved in FERC's March 13, 2019 Study Plan Determination for the Project. Boott intends to hold a two-day Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders to address data needs and conduct a Project site visit related to the above studies.

The Workshop will be held in Lowell, MA over two days in November 2019. The first day will focus on stakeholder consultation, information gathering, and data needs for the three studies mentioned above. Boott anticipates this first day will take place from 9am-4pm in Lowell, MA. Additional details regarding the meeting space to follow. The second day will consist of a site visit to target specific Project facilities associated with the studies.

Boott is proposing the following dates for the two-day Workshop:

November 12-13, 2019
November 13-14, 2019
November 14-15, 2019
November 19-20, 2019

Please notify Boott of the dates you can attend the Workshop by completing the poll here: https://www.surveymonkey.com/r/YQFX7LD . Boott has developed the attached Lowell Hydroelectric Project Study Workshop Agenda. In order to facilitate the scheduling of the Workshop, Boott is asking that all interested stakeholders complete the poll by November 6, 2019. If you have questions or need additional information, please contact Kevin Webb, Boott Hydro Licensing Manager, at (978) 935-6039 or via email at Kevin.Webb@enel.com.

Thank You –

Kelsey Scott, MS
Assistant Regulatory Specialist

HDR

1304 Buckley Road, Suite 202
Syracuse, NY 13212
D 315.414.2206 **M** 315.706.5176
kelsey.scott@hdrinc.com
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Agenda

Project:	Lowell Hydroelectric Project (FERC No. 2790)
Date/Time:	TBD
Location:	Lowell National Historic Park, Lowell MA
Subject:	**Lowell Hydroelectric Project Study Workshop**

Boott Hydropower, LLC (Boott), a subsidiary of Enel Green Power North America, Inc., is the Licensee and owner of the 20.2 megawatt Lowell Hydroelectric Project (FERC No. 2790) (Project). The Project is located on the Merrimack River in Middlesex County, Massachusetts, and in Hillsborough County, New Hampshire. The existing license for the Project was issued by the Federal Energy Regulatory Commission (FERC or Commission) with an effective date of May 1, 1973. The existing license expires on April 30, 2023. Accordingly, Boott is pursuing a new license for the Project pursuant to the Commission's Integrated Licensing Process, as described at 18 Code of Federal Regulations Part 5.

In support of Project relicensing, Boott is proposing to hold a two-day study workshop in Lowell, MA to consult with the National Park Service (NPS), Massachusetts Department of Conservation and Recreation (MADCR), City of Lowell (City), and other partners regarding certain studies approved in the Commission's March 13, 2019 Study Plan Determination for the Project. As described in the approved study plan, Boott is seeking information from the NPS, MADCR, and other partners regarding the Recreation and Aesthetics Study, the Historically Significant Waterpower Equipment Study, and the Water Level and Flow Effects on Historical Resources Study. The proposed two-day workshop will be an opportunity for consulting parties to share information and to identify the specific focus for field activities.

Day One: Data Needs and Information Gathering

The first day of the proposed workshop is intended to allow Boott, the NPS, MADCR, City, and other participating parties to discuss data needs and review available documentation. A proposed agenda for this day one of the workshop is presented below.

1. **Introduction**

    - Welcome and introduction
    - Overview and status of FERC relicensing process

2. **Recreation and Aesthetics Study**

    Study-specific Data Needs and Information Gathering

    - Recreation opportunities and access along the canal system;
    - Future use or planning documents that address anticipated or desired changes to the Lowell National Historic Park and Lowell Heritage State Park (e.g., The Foundation Report, or 5-year and 10-year plans);
    - Documentation of any reoccurring public safety issues or incidents within the parks associated with the canal infrastructure related to public recreation;
    - Annual maintenance schedules for the canal system;
    - Management or operations plans for the parks; and
    - Annual use records.

3. **Historically Significant Waterpower Equipment Study**

Study-specific Data Needs and Information Gathering

- Historically significant waterpower equipment owned and operated by Boott Hydropower of interest to the NPS for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;
- Engineering reports, drawings, and/or photographs related to historically significant waterpower equipment owned and operated by Boott Hydropower of interest to the NPS; and
- Components of historically significant waterpower equipment owned and operated by Boott Hydropower that will require photography and documentation.

4. **Water Level and Flow Effects on Historic Resources Study**

Study-specific Data Needs and Information Gathering

- Engineering reports or evaluations of historic canal structures, including documentation of previous maintenance and/or repairs related to canal water levels;
- Descriptions and/or photographs of properties that have been previously affected by canal operations; and
- Engineering and architectural drawings, maintenance records, and structural modifications of the Great River Wall.

5. **Action Items and Next Steps**

Day Two: Site Visit

Day two of the proposed workshop is focused on a site visit at the Project. The purpose of the site visit is to view locations identified during day one of the workshop, including:

- Areas of potential recreation enhancements and potential recreational access areas;
- Historically significant waterpower equipment selected by the NPS for documentation, including specific equipment to be photographed;
- Canal features that have been previously impacted by flows and water levels; and
- Areas along the canal system where waterborne trash collects.

Scott, Kelsey

To: Racine, Laurel
Subject: RE: [EXTERNAL] Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

From: Racine, Laurel [mailto:laurel_racine@nps.gov]
Sent: Monday, November 4, 2019 8:09 AM
To: Scott, Kelsey <Kelsey.Scott@hdrinc.com>
Subject: Re: [EXTERNAL] Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

Kelsey,
I'm writing because the NPS blocked my access to your poll. My participation would be most useful for the first day, not the site visits. Days I'm available for the day 1 workshop are November 12 or November 13, so either of the first two options are good for me. Thanks.
Laurel

_____
Laurel A. Racine, Chief of Cultural Resources
Lowell National Historical Park
67 Kirk Street
Lowell, MA 01852

Desk: 978-970-5055
Cell: (978) 423-3081

On Fri, Nov 1, 2019 at 2:24 PM Scott, Kelsey <Kelsey.Scott@hdrinc.com> wrote:

> Dear Stakeholders:
>
> Boott Hydropower, LLC (Boott) is pursuing a new license from the Federal Energy Regulatory Commission (FERC) for the continued operation of the Lowell Hydroelectric Project (FERC No. 2790)(Project) located along the Merrimack River. In support of Project relicensing, Boott is conducting a Recreation and Aesthetics Study, a Historically Significant Waterpower Equipment Study, and a Water Level and Flow Effects on Historic Resources Study, as approved in FERC's March 13, 2019 Study Plan Determination for the Project. Boott intends to hold a two-day Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders to address data needs and conduct a Project site visit related to the above studies.

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Thank You –

Kelsey Scott, MS

Assistant Regulatory Specialist

HDR

1304 Buckley Road, Suite 202
Syracuse, NY 13212

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kelsey.scott@hdrinc.com

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Scott, Kelsey

From: Hayes, Christopher <chayes@lowellma.gov>
Sent: Monday, November 4, 2019 9:59 AM
To: Scott, Kelsey
Cc: Ricker, Claire V.; McCall, Christine
Subject: RE: Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

Follow Up Flag: Follow up
Flag Status: Flagged

Hi, Kelsey,

Should I forward this to other potential interested stakeholders, or is the invitation limited to this list?

Thanks so much,
-Chris

Christopher Glenn Hayes | *Neighborhood Planner*
The City of Lowell|Department of Planning and Development
50 Arcand Drive|Lowell, MA 01852
t: 978.674.1405|f: 978.970.4262
http://www.lowellma.gov

LOWELL ***Alive. Unique. Inspiring.***

From: Scott, Kelsey [mailto:Kelsey.Scott@hdrinc.com]
Sent: Friday, November 01, 2019 2:24 PM
To: celeste_bernardo@nps.gov; christine_bruins@nps.gov; Paul_Fontaine@nps.gov; kevin_coffee@nps.gov; laurel_racine@nps.gov; peter_reitchel@nps.gov; kevin_mendik@nps.gov; duncan_hay@nps.gov; Emily.Byrne@mail.house.gov; darryl.forgione@mass.gov; patrice.kish@mass.gov; thomas.m.walsh@mass.gov; william.cooksey@mass.gov; peter.hoffmann@mass.gov; Tradd, Diane; Keefe Mullin, Kara; Thomas, Craig; Clancy, Christine; jwinward@lowellma.gov; Ricker, Claire V.; Hayes, Christopher; McCall, Christine; scerand@hotmail.com; greenesh@comcast.net; jcalvin@lowelllandtrust.org; ffaust@edgegroupinc.com
Cc: Quiggle, Robert; Webb, Kevin (EGP North America); elise.anderson@enel.com
Subject: Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

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Thank You –

Kelsey Scott, MS
Assistant Regulatory Specialist

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D 315.414.2206 **M** 315.706.5176
kelsey.scott@hdrinc.com
hdrinc.com/follow-us

Scott, Kelsey

To: Scott, Kelsey
Subject: RE: Update - Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

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From: Scott, Kelsey
Sent: Thursday, November 21, 2019 4:42 PM
To: 'celeste_bernardo@nps.gov' <celeste_bernardo@nps.gov>; 'christine_bruins@nps.gov' <christine_bruins@nps.gov>; 'Paul_Fontaine@nps.gov' <Paul_Fontaine@nps.gov>; 'kevin_coffee@nps.gov' <kevin_coffee@nps.gov>; 'laurel_racine@nps.gov' <laurel_racine@nps.gov>; 'peter_reitchel@nps.gov' <peter_reitchel@nps.gov>; 'kevin_mendik@nps.gov' <kevin_mendik@nps.gov>; 'duncan_hay@nps.gov' <duncan_hay@nps.gov>; 'Emily.Byrne@mail.house.gov' <Emily.Byrne@mail.house.gov>; 'darryl.forgione@mass.gov' <darryl.forgione@mass.gov>; 'patrice.kish@mass.gov' <patrice.kish@mass.gov>; 'thomas.m.walsh@mass.gov' <thomas.m.walsh@mass.gov>; 'william.cooksey@mass.gov' <william.cooksey@mass.gov>; 'peter.hoffmann@mass.gov' <peter.hoffmann@mass.gov>; 'dtradd@lowellma.gov' <dtradd@lowellma.gov>; 'KKeefeMullin@lowellma.gov' <KKeefeMullin@lowellma.gov>; 'cthomas@lowellma.gov' <cthomas@lowellma.gov>; 'cclancy@lowellma.gov' <cclancy@lowellma.gov>; 'jwinward@lowellma.gov' <jwinward@lowellma.gov>; 'CRicker@lowellma.gov' <CRicker@lowellma.gov>; 'chayes@lowellma.gov' <chayes@lowellma.gov>; 'CMcCall@lowellma.gov' <CMcCall@lowellma.gov>; 'scerand@hotmail.com' <scerand@hotmail.com>; 'greenesh@comcast.net' <greenesh@comcast.net>; 'jcalvin@lowelllandtrust.org' <jcalvin@lowelllandtrust.org>; 'ffaust@edgegroupinc.com' <ffaust@edgegroupinc.com>; 'Euris Gonzalez (DCR) (Euris.Gonzalez@mass.gov)' <Euris.Gonzalez@mass.gov>
Cc: 'Anderson, Elise (EGP North America)' <elise.anderson@enel.com>; 'Webb, Kevin (EGP North America)' <Kevin.Webb@enel.com>; Quiggle, Robert <Robert.Quiggle@hdrinc.com>
Subject: RE: Update - Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

Dear Stakeholders:

Based on the results of recent scheduling polls, we are confirming that the Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders will occur over two days from December 18—19, 2019. The first day will focus on stakeholder consultation, information gathering, and data needs for the three studies listed in the attached agenda. Boott anticipates this first day will take place from 9am-4:30pm in Lowell, MA at the National Park Service Headquarters for the Lowell National Historical Park. The second day will consist of a site visit to target specific Project facilities associated with the studies. Boott anticipates this second day site visit to occur from 9am-12pm.

Additional information will follow this email in the weeks ahead of the Workshop meeting. Should you have any questions about the Workshop, please contact me at the phone number or email address below, or contact Mr. Kevin Webb, Enel Hydro Licensing Manager, at 978-935-6039 or via email at Kevin.Webb@enel.com.

Thank You –

Kelsey Scott, MS
Assistant Regulatory Specialist

HDR
1304 Buckley Road, Suite 202
Syracuse, NY 13212
D 315.414.2206
kelsey.scott@hdrinc.com
hdrinc.com/follow-us

From: Scott, Kelsey
Sent: Friday, November 8, 2019 11:17 AM
To: 'celeste_bernardo@nps.gov' <celeste_bernardo@nps.gov>; 'christine_bruins@nps.gov' <christine_bruins@nps.gov>; 'Paul_Fontaine@nps.gov' <Paul_Fontaine@nps.gov>; 'kevin_coffee@nps.gov' <kevin_coffee@nps.gov>; 'laurel_racine@nps.gov' <laurel_racine@nps.gov>; 'peter_reitchel@nps.gov' <peter_reitchel@nps.gov>; 'kevin_mendik@nps.gov' <kevin_mendik@nps.gov>; 'duncan_hay@nps.gov' <duncan_hay@nps.gov>; 'Emily.Byrne@mail.house.gov' <Emily.Byrne@mail.house.gov>; 'darryl.forgione@mass.gov' <darryl.forgione@mass.gov>; 'patrice.kish@mass.gov' <patrice.kish@mass.gov>; 'thomas.m.walsh@mass.gov' <thomas.m.walsh@mass.gov>; 'william.cooksey@mass.gov' <william.cooksey@mass.gov>; 'peter.hoffmann@mass.gov' <peter.hoffmann@mass.gov>; 'dtradd@lowellma.gov' <dtradd@lowellma.gov>; 'KKeefeMullin@lowellma.gov' <KKeefeMullin@lowellma.gov>; 'cthomas@lowellma.gov' <cthomas@lowellma.gov>; 'cclancy@lowellma.gov' <cclancy@lowellma.gov>; 'jwinward@lowellma.gov' <jwinward@lowellma.gov>; 'CRicker@lowellma.gov' <CRicker@lowellma.gov>; 'chayes@lowellma.gov' <chayes@lowellma.gov>; 'CMcCall@lowellma.gov' <CMcCall@lowellma.gov>; 'scerand@hotmail.com' <scerand@hotmail.com>; 'greenesh@comcast.net' <greenesh@comcast.net>; 'jcalvin@lowelllandtrust.org' <jcalvin@lowelllandtrust.org>; 'ffaust@edgegroupinc.com' <ffaust@edgegroupinc.com>
Cc: 'Anderson, Elise (EGP North America)' <elise.anderson@enel.com>; Webb, Kevin (EGP North America) <Kevin.Webb@enel.com>; Quiggle, Robert <Robert.Quiggle@hdrinc.com>
Subject: Update - Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

Dear Stakeholders –

Due to scheduling conflicts, Boott is resurveying this group for available dates to hold the two-day Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders. The first day of the Workshop will focus on stakeholder consultation, information gathering, and data needs. Boott anticipates this first day will take place from 9am-4:30pm in Lowell, MA. Additional details regarding the meeting space to follow. The second day will consist of a site visit to target specific Project facilities.

Boott is proposing the following dates for the two-day Workshop:

December 4-5, 2019
December 5-6, 2019
December 9-10, 2019
December 10-11, 2019
December 11-12, 2019
December 17-18, 2019
December 18-19, 2019

Please notify Boott of the dates you can attend the Workshop by completing the Doodle Poll here: https://doodle.com/poll/dp2qb9232aq66awg

In order to facilitate the scheduling of the Workshop, Boott is asking that all interested stakeholders complete the poll by November 13, 2019. If you have questions or need additional information, please contact Kevin Webb, Boott Hydro Licensing Manager, at (978) 935-6039 or via email at Kevin.Webb@enel.com.

Thank You –

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Scott, Kelsey

From: Scott, Kelsey
Sent: Monday, December 9, 2019 3:55 PM
To: 'celeste_bernardo@nps.gov'; 'christine_bruins@nps.gov'; 'Paul_Fontaine@nps.gov'; 'kevin_coffee@nps.gov'; 'laurel_racine@nps.gov'; 'peter_reitchel@nps.gov'; 'kevin_mendik@nps.gov'; 'duncan_hay@nps.gov'; 'Emily.Byrne@mail.house.gov'; 'darryl.forgione@mass.gov'; 'patrice.kish@mass.gov'; 'thomas.m.walsh@mass.gov'; 'william.cooksey@mass.gov'; 'peter.hoffmann@mass.gov'; 'dtradd@lowellma.gov'; 'KKeefeMullin@lowellma.gov'; 'cthomas@lowellma.gov'; 'cclancy@lowellma.gov'; 'jwinward@lowellma.gov'; 'CRicker@lowellma.gov'; 'chayes@lowellma.gov'; 'CMcCall@lowellma.gov'; 'scerand@hotmail.com'; 'greenesh@comcast.net'; 'jcalvin@lowelllandtrust.org'; 'ffaust@edgegroupinc.com'; 'Euris Gonzalez (DCR) (Euris.Gonzalez@mass.gov)'
Cc: 'Anderson, Elise (EGP North America)'; 'Webb, Kevin (EGP North America)'; Quiggle, Robert
Subject: RE: Update - Lowell Hydroelectric Project (FERC No. 2790) Study Workshop
Attachments: December 2019 Lowell Study Workshop Agenda.pdf

Dear Stakeholders:

The agenda is attached for the upcoming December 18 – 19, 2019 Study Workshop & Site Visit for the Lowell Hydroelectric Project. Boott appreciates the opportunity to consult with stakeholders and we look forward to seeing you next week.

Should you have any questions about the Study Workshop, please contact me at the phone number or email address below, or contact Mr. Kevin Webb, Enel Hydro Licensing Manager, at 978-935-6039 or via email at Kevin.Webb@enel.com.

Thank You –

Kelsey Scott, MS
Assistant Regulatory Specialist

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From: Scott, Kelsey
Sent: Thursday, November 21, 2019 4:42 PM
To: 'celeste_bernardo@nps.gov' <celeste_bernardo@nps.gov>; 'christine_bruins@nps.gov' <christine_bruins@nps.gov>; 'Paul_Fontaine@nps.gov' <Paul_Fontaine@nps.gov>; 'kevin_coffee@nps.gov' <kevin_coffee@nps.gov>; 'laurel_racine@nps.gov' <laurel_racine@nps.gov>; 'peter_reitchel@nps.gov' <peter_reitchel@nps.gov>; 'kevin_mendik@nps.gov' <kevin_mendik@nps.gov>; 'duncan_hay@nps.gov' <duncan_hay@nps.gov>; 'Emily.Byrne@mail.house.gov' <Emily.Byrne@mail.house.gov>; 'darryl.forgione@mass.gov' <darryl.forgione@mass.gov>; 'patrice.kish@mass.gov' <patrice.kish@mass.gov>; 'thomas.m.walsh@mass.gov' <thomas.m.walsh@mass.gov>; 'william.cooksey@mass.gov' <william.cooksey@mass.gov>; 'peter.hoffmann@mass.gov' <peter.hoffmann@mass.gov>; 'dtradd@lowellma.gov' <dtradd@lowellma.gov>; 'KKeefeMullin@lowellma.gov' <KKeefeMullin@lowellma.gov>; 'cthomas@lowellma.gov' <cthomas@lowellma.gov>; 'cclancy@lowellma.gov'

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Cc: 'Anderson, Elise (EGP North America)' <elise.anderson@enel.com>; 'Webb, Kevin (EGP North America)' <Kevin.Webb@enel.com>; Quiggle, Robert <Robert.Quiggle@hdrinc.com>
Subject: RE: Update - Lowell Hydroelectric Project (FERC No. 2790) Study Workshop

Dear Stakeholders:

Based on the results of recent scheduling polls, we are confirming that the Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders will occur over two days from December 18—19, 2019. The first day will focus on stakeholder consultation, information gathering, and data needs for the three studies listed in the attached agenda. Boott anticipates this first day will take place from 9am-4:30pm in Lowell, MA at the National Park Service Headquarters for the Lowell National Historical Park. The second day will consist of a site visit to target specific Project facilities associated with the studies. Boott anticipates this second day site visit to occur from 9am-12pm.

Additional information will follow this email in the weeks ahead of the Workshop meeting. Should you have any questions about the Workshop, please contact me at the phone number or email address below, or contact Mr. Kevin Webb, Enel Hydro Licensing Manager, at 978-935-6039 or via email at Kevin.Webb@enel.com.

Thank You –

Kelsey Scott, MS
Assistant Regulatory Specialist

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Thank You –

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Agenda

Project: Lowell Hydroelectric Project (FERC No. 2790)

Subject: Lowell Project Study Workshop & Site Visit

Date: December 18 – 19, 2019

Location: Lowell National Historical Park Visitor Center (246 Market Street), Lowell, MA.

Pursuant to the Federal Energy Regulatory Commission's (FERC or Commission) Study Plan Determination (SPD) for the relicensing of the Lowell Hydroelectric Project (FERC No. 2790) (Project), Boott Hydropower, LLC (Boott) will conduct a Recreation and Aesthetics Study, a Water Level and Flow Effects on Historic Resources Study, and a Historically Significant Waterpower Equipment Study (collectively Studies). This Study Workshop to consult with stakeholders regarding these Studies will be held from 9:00 AM until 4:00 PM at the Lowell National Historical Park Visitor Center (246 Market Street) in Lowell, MA. The adjacent parking at 304 Dutton Street is free. On the following day after the Study Workshop, stakeholders are invited to participate in a site visit of the Project to consult on the field portion of the Studies, which is expected to end at noon. The proposed agenda for the Study Workshop is as follows:

Welcome and Introductions ..... 9:00 AM – 9:30 AM

Discussion of FERC Relicensing and ILP Study Process ..... 9:30 AM – 10:00 AM

Break ..... 10:00 AM – 10:15 AM

Recreation and Aesthetics Study Needs ..... 10:15 AM – 11:15 AM

Water Level and Flow Effects on Historic Resources Study Needs ..... 11:15 AM – 12:00 PM

Lunch Break ..... 12:00 PM – 1:00 PM

Historically Significant Waterpower Equipment Study Needs ..... 1:00 PM – 2:00 PM

Open discussion/Break ..... 2:00 PM – 3:00 PM

Upcoming ILP Schedule (2020-2021) ..... 3:00 PM – 3:30 PM

Action Items and Next Steps ..... 3:30 PM – 4:00 PM

Scott, Kelsey

From: Bruins, Christine <christine_bruins@nps.gov>
Sent: Thursday, December 19, 2019 9:22 AM
To: Webb, Kevin (EGP North America); Scott, Kelsey; Quiggle, Robert
Cc: Mendik, Kevin; Duncan Hay
Subject: Lowell NHP Exotic Species Treatment Schedule - Vegetation Mgmt
Attachments: 2018.9.11 EXOTIC SPECIES TREATMENT LOWELL.docx

Hi folks,

Thank you so much for hosting a meeting with the canal stewardship partners. I'm attaching a document from our maintenance department which outlines the exotic species that exist along the canals and treatment schedules.

Christine Bruins | Community Planner
Lowell National Historical Park
978.275.1726 (office) | 978.954.1011 (cell)

EXOTIC SPECIES TREATMENT CALENDAR FOR LOWELL NATIONAL HISTORICAL PARK

Prepared by Lars Boyd, Sept 11, 2018.

OUTLINE

I. Purpose of document

II. Target species for 2019

III. Tentative Treatment Calendar

IV. Best Management Practices

V. Brief description of each species with photos and treatment strategies

I. PURPOSE

This document provides a series of tables and exotic plant management information to aid in organizing of a 2019 treatment schedule for Lowell NHP.

This document will present an appropriate species to be focused on in a park for the given, and a potential control method. Often other species may be treated at the same time as the target species if the appropriate treatment method is able to be performed concurrently. For foliar spraying, a generic herbicide mixture can be used to treat a broad spectrum of species within the same day. A generic herbicide mixture can be applied to multiple species for basal bark and cut stem/stump treatments as well. Refer to the individual species treatment guides (Table 6-13) to determine if the application method is appropriate within the given time window before treating other species in the area with herbicide.

II. TARGET SPECIES FOR 2019 LOWELL NHP

Table 1: Reported Target Species W/ Locations for FY 2019

Species	NCW	BSS	FG	SW/JS	DSC&T	KP	VCC	TT	KSH	WCW
Ailanthus altissima (Tree of Heaven)	X		X		X					X
Alliaria petiolata (Garlic mustard)		X	X	X		X			X	
Celastrus orbiculatus (Asiatic Bittersweet)	X		X		X	X				X
Convolvulus arvensis (Bind Weed)										X
Cynanchum louiseae (Black Swallow-wort)	X			X	X	X	X	X		X
Fallopia japonica (Japanese Knotweed)		X		X	X					
Lythrum salicaria (Purple Loosestrife)	X			X						X
Rosa multiflora (Multiflora Rose)										X

NCW- Northern Canal Walkway
BSS- Black Smith Shop
FG- Francis Gate
SW/JS- Swamp Locks/Jackson St
DSC&T- Dutton St Canal & Tracks
KP- Kerouac Park
VCC- Visitor Center Courtyard
TT- Tremont St Tracks
KSH- Kirk St Headquarters
WCW- Western Canal Walkway

III. TENTATIVE CALENDAR FOR LOWELL NHP EXOTIC PLANT REMOVAL

Table 2: Foliar Spray Treatment Sequencing

Species	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Rosa multiflora (Multiflora Rose)			X	X					
Ailanthus altissima (Tree of Heaven)				X	X	X			
Cynanchum louiseae (Black Swallow-wort)				X	X				
Convolvulus arvensis (Bindweed)					X	X	X		
Fallopia japonica (Japanese Knotweed)						X	X		
Lythrum salicaria (Purple Loosestrife)						X			
Alliaria petiolata (Garlic mustard)							X	X	
Celastrus orbiculatus (Asiatic Bittersweet)								X	X

IV. BEST MANAGEMENT PRACTICES (ADOPTED FROM THE EXOTIC SPECIES TREATMENT CALENDAR FOR BOSTON METROPOLITAN PARKS by Lyndon Langthorne)

Non-chemical Treatment

Non-chemical treatment, when appropriate for the target species, should be attempted before chemical treatment. In most situations, chemical treatment can be made more effective when applied in conjunction with non-chemical management strategies. Non-chemical management strategies are generally labor intensive, but can be performed in most areas, including areas where chemical treatment would not be advisable.

Table 3. Non-chemical Treatment Methods

Hand pulling	Manual removal of top growth of plant, and as much of the root system as possible. Extensive, deep, and large root systems are not removable by hand. Hand pulling will prevent the formation of seed pods if consistently implemented throughout the growing season. This method is often not effective in managing regenerative species. Rhizomatous species are not generally manageable through this strategy alone.
Digging	Manual or mechanical removal of root system when hand pulling alone is not sufficient in removing the root system. Species that re-

	sprout from roots must have the root system removed. Digging is labor intensive. This method is not viable when managing regenerative plants with extensive, deep, or large roots. Digging disturbs the soil, encouraging colonization by other exotic species.
Cutting	Manual removal of the entire top growth of the plant by cutting the stem close to the ground. Plant matter removed by cutting may, depending on the species and desired conditions, be allowed to compost (either where it is cut or moved to another location), or destroyed to prevent reshooting of roots. Cutting can be effective on annuals or biennials if done before seeding, but in most perennial species, cutting alone is not capable of achieving control. Stump grinding of larger, woody stumps can prevent reshooting (e.g. *F. alnus*, *R. cathartica*, *A. altissima*). Herbicide can be applied to the cut surface to destroy the roots and prevent reshooting.
Flower clipping / Seed-heading	Manual removal of flowers or seed heads to prevent seeding or seed spread, but not removal of the plant top growth; seeds collected are destroyed. This method will limit the ability of the plant to spread through seeding, but will not prevent vegetative spread by the root system. Some plants do not rely on seeds as the primary vector of spread (e.g. *F. japonica*).
Mulching / Mats / ”Buckthorn Bags”	Covering of a disturbed or treated area to limit the ability of exotic species to grow and recolonize an area. Mulch can be layered over soil, and possible supplemented with a permeable material, like cloth or paper, to limit the ability of exotics to reshoot while also providing an area that can be used for planting. Reshooting may still occur with mulch, and monitoring is advisable. Mats of rubber or black plastic can be layered on the soil as an impervious surface. This surface cannot be used for planting, but is more likely to prevent any regrowth. If the mats are in an area of direct or partial sunlight, the heat collected will kill covered roots. “Buckthorn bags” can be placed over stumps of *F. alnus* and *R. cathartica* that are over two inches in diameter. Left in place for two years, these bags will prevent regeneration and destroy the root system of the plant.
Mowing	Mechanical removal of top growth of plants. Able to be applied quickly to large areas. Mowing is less precise than most manual methods, and is most viable on land that is already managed land. Will not destroy the root system of most plants, but often stresses the plant and prevents seed production if done consistently. Herbicide applied after mowing will often be more effective, either applying immediately after mowing as cut stem/stump treatment, or upon regrowth as a foliar spray.

Stump grinding	Perennial shrubs and trees can have their stumps ground to prevent reshooting.

Seeds forming on exotic plants should always be removed when observed. Removal of seeds can be a valuable management strategy in areas of lower priority, or where other management strategies are inadvisable. Seed removal will not disrupt existing plants, but will limit growth and spread of these populations. Seed removal also prevents exotics from further contributing to the soil seed bank, all the viable seeds existing within the soil of an area. Seeds of exotics should be burned or bagged and disposed of in a landfill to prevent further contamination.

Bare patches of soil, particularly those remaining after soil is disturbed by digging or hand pulling, is vulnerable to colonization by new exotic species. To mitigate this threat, new plants and grasses should be added to bare areas whenever possible. If a bare patch was the site of chemical treatment that will be repeated the following year, seed of an inexpensive annual ryegrass can be planted to limit the cost of further chemical treatments.

Chemical Treatment

Use pesticides at rates recommended by the label, and never exceed labeled rates. Mitigate damage to other plants and ecosystems by taking care for herbicide drift. Only apply herbicides on calm, dry days, and never any closer to standing water than is specified on the label. Herbicide applicators should always be properly fitted with Personal Protective Equipment (PPE) required by label, which represents the **minimum** PPE required for use. When applying chemicals, it is advisable to add a dye to the mix, unless otherwise stipulated, to better mark which plants have been treated. Dyes also allow contaminated gear to be easily identified for safety reasons.

Table 4. Chemical Treatment Method Overview

Foliar Spray	Broadcast or spot application of herbicide with a sprayer targeting foliage of species, wetting the leaves with herbicide to be absorbed into the root system. Apply to intact, green leaves. This is often the most efficient herbicide application method. Lower concentrations are used with foliar spray than other application methods. Foliar spray has the greatest potential to unintentionally damage surrounding plants, and may not be preferred for this reason. Foliar application is best for treating large, dense stands of invasive plants where risk of damaging surrounding plants can be minimized. When spraying, herbicide should wet leaves without dripping, as excessive spraying can harm non-target species. The extent of the application depends on the size of the area being treated. Spot spraying is application of herbicide in one location,

	generally to one plant. This type of application minimizes damage to surrounding plants. Broadcast application is more extensive than spot spraying for heavier infestations. Foliar spraying should not be performed on wet weather days as any herbicide may not be absorbed into plants, instead being washed away as runoff. Foliar spraying should not be performed on days when wind speeds are greater than 5 mph to prevent pesticide drift. Foliar spraying should also not be performed in areas where damage to non-target species is a concern. Large trees should not be treated by foliar spray.
Cut Stem/Stump	Application of herbicide either by brush or spray bottle to a cut surface to be absorbed into the root system. After cut, herbicide should be applied to the cut surface immediately for best effect, and not more than 15 minutes later; this time limit is particularly important for the best absorption of water-based herbicides, and oil based herbicides can be applied longer after cutting. Cut stump applications are more effective than basal bark on woody stems greater than 5” diameter, and thick barked species.
Basal Bark	Application of herbicide to the bark with a sprayer, from surface to 12-18 inches above the root collar, to be absorbed into root system. Useful in precisely controlling woody species. Treatment can be performed while herbaceous species are dormant. Uses oil-based herbicides that penetrate bark, mixed with a carrier (basal oil). The entire surface area of the trunk should be coated within the 12-18 inch range, and rough bark requires more spray. Application should be stopped short of runoff.
Stem Injection	Application of herbicide into the stems of hollow plants via specialized injection equipment. This method ensures absorption of the herbicide into the roots of the plant, and limits exposure to and contamination by pesticides.
Hand Wicking (“Glove of death”)	Application of herbicide to the leaf surface with an absorbent cotton glove coated in herbicide layered over a chemical resistant glove. Small spray bottles are used to wet the fingertips and palm of the glove, which is then wiped directly on the plant, coating the leaves. This method is precise, faster than cut stem/stump treatment, and limits exposure of herbicide to other plants. Cuff the ends of the glove to prevent dripping. Gloves used for this method will becomes saturated with herbicide and should not be stored with other equipment.

Herbicides

Use with caution.
Be aware of local regulations before use.
Always read the label thoroughly before use, and follow all requirements (including PPE, site location, concentration, etc.).

Chemicals should be chosen based on a variety of factors, including: effectiveness on target species, environmental impact (toxicity to animals, persistence in soil, activity in water), and safety. The correct herbicide should be chosen for the site, and herbicide labelling will list use sites.

Table 5. General Overview of Commonly Used Herbicides

Glyphosate	(*Rodeo®*)	Glyphosate is a non-selective systemic post-emergent herbicide, damaging to most plants, including broadleaf plants and grasses. Pure glyphosate is generally environmentally safe, essentially non-toxic to mammals and fish, and mildly toxic to birds. Glyphosate is quickly absorbed into soil, and has negligible lasting environmental effects, and leaching to other areas is not expected to occur. Glyphosate has a short half-life in soil and water. Glyphosate may or may not be metabolized by plants, and potentially persists in plants where it was applied, including in the roots. Be aware that not all glyphosate herbicides are registered for aquatic use, and some formulations are contain adjuvants that make them highly toxic to aquatic life. If using in an aquatic area, be sure to use a product that omits these toxic ingredients (eg. *Rodeo®*). Pure glyphosate has low human toxicity, but is often made more hazardous to humans with adjuvants that disseminate the chemical into plants. Causes significant eye irritation.
Triclopyr amine	(*Garlon® 3A*)	Triclopyr is a selective systemic post-emergent herbicide. It is relatively non-toxic to humans and terrestrial mammals, and some formulations are registered for aquatic use. Triclopyr should generally be used in areas where it is desired to protect surrounding grasses and sedges. Triclopyr amine is preferred for foliar applications over triclopyr ester.

Triclopyr ester	(*Garlon® 4 Ultra)*	Triclopyr is a selective systemic post-emergent herbicide. It is relatively non-toxic to humans and terrestrial mammals. It is not registered for aquatic use. Triclopyr ester is only recommended as a foliar spray prior to full leaf-out of the target plant. After leaf out, other herbicides would be preferred. Good for basal barking when mixed with a basal oil. Cannot be used within 35 ft. of wetland.
Imazapyr	(*Plateau®, Habitat®*)	Imazapyr is a non-selective, systemic, pre- and post-emergent herbicide. Imazapyr formulations can be registered for aquatic use. Imazapyr has a low human toxicity in skin contact or if ingested. Harmful if inhaled and may cause irreversible eye damage.

A good strategy for foliar application efficiency is to mix a general formulation of triclopyr amine and glyphosate. This mixture can be applied on a wide spectrum of species, and allow more treatment to occur during a single application session.

V. BRIEF DESCRIPTION OF EACH TARGET SPECIES (ADOPTED FROM THE EXOTIC SPECIES TREATMENT CALENDAR FOR BOSTON METROPOLITAN PARKS by Lyndon Langthorne)

Ailanthus altissima (Tree of Heaven)

Description

https://www.extension.iastate.edu/forestry/iowa_trees/trees/tree_of_heaven.html

A. altissima is a large non-native short-lived deciduous perennial tree. The trunk grows up to eighty feet tall, and is straight and gray, with smooth to bumpy bark that fissures with age. Leaves are silvery-green and pinnately compound, with alternate leaflets on one to four foot leaf veins. Leaves produce a foul smell if crushed. Five-petaled flowers are small, yellow-green, and grow in dense clusters. Reddish-brown seed pods are produced in late summer, and are twisted like helicopters, each containing one seed

The tree is resilient, and will grow in a wide range of environments, including urban where the root system can disrupt hardscaping and cause damage to structures. *A. altissima* crowds out native trees quickly with its ability to spread quickly to new areas. The roots are toxic and may limit growth potential for native plants.

Non-chemical Treatment

Seedlings and root suckers should be dug consistently to control spread. Any remaining stumps and roots will continue to generate new shoots. Cutting and mowing alone are not an effective form of management, and may increase density and spread potential. Mechanical measures that remove top growth are most effective when followed up by chemical treatment.

Chemical Treatment

Foliar spraying is the most common form of treatment for *A. altissima*] Foliar treatment best applied between full canopy and fall color. Foliar application cannot be applied to larger trees, and is most effective in treating dense stands of saplings.

Cut stump treatment is a more labor intensive method, but may be necessary in treating larger trees. After cutting tree, immediately apply herbicide to cut surface. Cutting alone will lead to increased suckering, and should be mitigated with herbicide application

Basal bark used for follow up treatments or small infestations. Root injury is maximized when used after full canopy to fall color. Following basal bark treatment, the tree is left in place to be cut at a later time. *A. altissima* may require multiple applications.

To maximize root damage, any chemical treatment should be performed within the time window where the tree has developed its full canopy and before the leaves have turned to fall colors.

Table 6: *A. altissima* Treatment Guide

Application Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand pulling					Apr - Jun	Seedlings and saplings
Chemical Treatment						
Foliar	Glyphosate	*Rodeo®*	Non-selective	2%	Late Jun - Aug	Surfactant
	Triclopyr	*Garlon® 3A*	Selective	2%		
		Garlon® 4 Ultra		1.5%		
	Imazapyr	*Habitat®*	Non-selective	1%		
Cut stem/stump	Triclopyr	*Garlon® 3A, Garlon® 4 Ultra*	Selective	50%	Late Jun - Aug	
Basal bark	Triclopyr ester	*Garlon® 4 Ultra*	Selective	20-25%[1]	Mar - Oct[1]	Basal oil

Notes:
1. Contributed by BM

Alliaria petiolata (Garlic Mustard)

Description

https://www.michigan.gov/invasives/0,5664,7-324-68002_71240_73853-379483--,00.html

A. petiolata is a non-native biennial herb. First year plants are immature and resemble many native plants, such as *Viola*. In its first year leaves stay green all year long. *A. petiolata* is much easier to identify in the second year after bolting. In the second year, the leaves take on a garlicky odor and the stem forms up to three feet in height. Leaves are alternate, sharply toothed, and triangular. Flowers bloom early in the season and are white with four petals. Seed pods develop atop the stem and burst to project seeds up to five feet from the plants, leading to rapid expansion of patches. *A. petiolata* produces more seeds in wet environments.

A. petiolata populations can grow rapidly when unchecked. Roots of *A. petiolata* have an allelopathic effect on native plants, limiting growth potential in areas of infestation. The plant provides no benefits as a food source for native animal species.

Non-chemical Treatment

Stems are attached to a single root, and plants can be removed entirely by pulling, particularly in moist and loose soil. Plants can also be dug. These methods can be an effective for control, but disturbs soil and leaves bare patches, which can be recolonized. Roots must be removed completely to prevent resprouting and are easily broken.

Mowing or cutting of *A. petiolata* in its second year after bolting can also be an effective management strategy, destroying plants, especially those already under stress, and preventing seed development.

Clipping and removing of flowers will prevent the formation of new seeds, and will reduce population growth rates.

These methods must be repeated over many years until seed bank is depleted. Size of the seed bank depends on the age of the population. When utilizing these methods, it is important to clean any equipment used or worn in order to prevent seed spread.

Chemical Treatment

Foliar spray is the recommended method for chemical treatment of A. petiolata, if chemical treatment is deemed necessary. Leaves should be cleaned of debris prior to application to ensure absorption into the plant. Glyphosate and triclopyr amine application to rosettes is most effective in late fall, and is best used only on dense stands where non-chemical treatment would be prohibitively laborious. Triclopyr amine can be used to avoid damaging surrounding grasses.

Table 7. *A. petiolata* Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand pulling					Apr - Oct	
Mowing					Aug - Oct	Most effective if plants are already under stress (drought, etc.)
Flower clipping					Apr - Jun	
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	0.5-1%[1]	Sep - Oct	
	Triclopyr amine	*Garlon® 3A*	Selective	0.5-1%[1]		

Notes:
1. Contributed by BM

Celastrus orbiculatus (Asiatic Bittersweet)

Description

C. orbiculatus is a non-native deciduous woody perennial that grows as either a vine or a shrub. Stem is woody with smooth brown bark. Leaves are alternate, glossy, and round with a pointed tip and shallow toothed margins. The leaves grow from two to five inches in length. Small greenish-yellow flowers with five petals form at leaf axils in clusters. Fruits are distinctive, in round orange capsules that split open in fall revealing fleshy red fruits with one or two seeds each.

https://orleansconservationtrust.org/asiatic-bittersweet-celastrus-orbiculatus/

The fruits persist throughout winter, and are highly attractive to birds and other animals, and to humans who often use vines and fruits in decorative manners. *C. orbiculatus* can spread far as seed, and is also capable of root suckering.

C. orbiculatus looks very similar to *C. scandens* (American Bittersweet), particularly when young. As the plant matures, it distinguishes itself with the placement of the fruit: *C. scandens* develops fruit on the tips of its branches, whereas *C. orbiculatus* develops fruits on the leaf axils. *C. scandens* leaves are also less round. Hybridization makes identification difficult. *C. orbiculatus* may be sold as *C. scandens* due to the difficulty in identification.

C. orbiculatus displaces native species through competition, and also displaces *C. scandens* through hybridization, potentially threatening *C. scandens* genetic identity. *C. orbiculatus* grows rapidly and can quickly dominate areas it is introduced into. *C. orbiculatus* also twines around native trees, increasing the load on limbs and contributing to failure.

Non-chemical Treatment

Smaller plants can be hand pulled or dug out. The entire root should be removed to prevent resprouting.

Vines climbing into trees can be cut at a comfortable height to kill any of the vine in the canopy and relieve trees. The base of the vine will continue to grow, and will require

continued treatment to manage. When cutting vines from trees, take care to limit damage done to the bark of the tree as much as possible, for the sake of continued tree health.

Chemical Treatment

Foliar spraying of triclopyr is recommended for large, dense patches. Foliar spray is best applied in autumn or early winter, after most other species are dormant. If the vine is fully leafed out at the time of spraying, it is recommended to use triclopyr amine over the ester form. Foliar spray should only be applied on calm days when ambient air temperature is above the required sixty-five degrees Fahrenheit.

Vines of the plant that grow up into the canopy cannot viably be treated with a foliar application. The cut stump method is preferable for *C. orbiculatus* vines that climb trees, as well as for vines that are in close proximity to desired plants. When cutting, cut the vine six inches above the ground, in case more cut stump applications are required. Immediately apply the herbicide with a brush or spray bottle. Cut stump treatment can be used at any time in the year as long as the ambient air temperature is above the necessary temperatures: forty degrees Fahrenheit for glyphosate application, and sixty-five degrees Fahrenheit for triclopyr application. The ground should not be frozen at the time of application.

Basal bark treatment with triclopyr ester can also be applied at any time in the year, if the ambient air temperature has been above the required sixty-five degrees Fahrenheit for several days. Basal bark treatment should also not be done if there is snow on the ground, or if any part of the application area is wet from rain or flooding. Before applying, cut any stems sprouting from the vine within the twelve to eighteen inch application range to reveal the bark, and apply the treatment to cover the entire of that area.

Systemic herbicides should destroy an entire *C. orbiculatus* plant in a week.

Table 8. *C. orbiculatus* Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand pulling					Mar - Nov	Small plants
Cutting					Mar - Nov	Will kill any climbing vines in canopy to relieve tree, will not destroy roots
Chemical Treatment						
Foliar spray	Triclopyr	*Garlon® 3A*, *Garlon® 4 Ultra*	Selective	2%	Oct - Nov	Use late season so most native species are dormant; ambient temperature should still be above 65 degrees F
Cut stem/stump	Glyphosate	*Rodeo®*	Non-selective	25%	Year round	Ambient air temperature above 40°F
	Triclopyr	*Garlon® 3A*, *Garlon® 4 Ultra*	Selective			Ambient air temperature above 65°F, no frozen ground
Basal bark	Triclopyr ester	*Garlon® 4 Ultra*	Selective	20%	Year round	Should only be performed when ambient air temperature has been above 65°F for several days

Cynanchum louiseae (Black Swallow-wort)

Description

https://www.maine.gov/dacf/mnap/features/invasive_plants/cynanchum.htm

C. louiseae is a non-native rhizomatous perennial milkweed. Stems are yellowish-green, long and thin, vine-like and twining. The stems tend to climb and twist around other plant stems or themselves. Leaves are opposite, smooth, shiny, dark green, and elliptic or heart shaped with sharp tips. Flowers are small and dark purple, with five petals. *C. louiseae* has milkweed-like seed pods, with many small brown seeds attached to fluffy white hairs.

C. louiseae is spread long distances by its seeds, which float in wind, and many seeds will drop into already infested areas, increasing the density of *C. louiseae* in patches.

C. louiseae outcompetes native species and forms sprawling and dense mats of plant matter that completely cover areas, limiting the growth potential for native species. It will also twine around native species, stressing those plants and limiting ability to grow.

Non-chemical Treatment

Non-chemical treatment of C. louiseae has limited effects for control. Hand pulling or mowing the part of the plant above soil prevents the development of seed pods, limiting the ability of the plant to spread; this is not an effective method of long-term control.

Digging the roots of the plant is labor intensive, and any control established is limited as the plant will resprout from any remaining rhizomatous matter. The entire crown and root system must be removed in order to control by digging.

Any seed pods that do form should be pulled by hand and bagged or burned to prevent propagation.

Chemical Treatment

C. louiseae is a pervasive species and will require multiple years of treatment to achieve control. It is very important to not apply herbicide too early in the season when treating *C. louiseae*. While the shoots emerge in the early spring, herbicide should only be applied after the plants have begun to flower in June or July, and must be applied before the formation of seed pods. Foliar spraying before the formation of seed pods will greatly reduce seed viability in affected plants.

Foliar spray is optimal when treating large monotypic stands of *C. louiseae*. If the exotic plants are surrounded by desired grasses, then triclopyr can be used minimize damage to grasses. Plants will appear sick one to two weeks after herbicide treatment, exhibiting yellowed leaves, and dead spots. Do not reapply herbicide to plants that are sick, as sick plants cannot effectively absorb herbicides into roots.

For particularly sensitive areas, cut stem treatment of *C. louiseae* is a viable control method. Stems should be cut to about two inches from the ground, and non-selective herbicide should be applied immediately.

Table 9. *C. louiseae* Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand-pulling					Aug - Nov	Target seedpods
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	3-5%	June - July	Spray as plants begin to flower
	Triclopyr	*Garlon® 3A*, *Garlon® 4 Ultra*	Selective	1%		
	Imazapyr	*Habitat®*				
Cut stem/stump	Glyphosate	*Rodeo®*	Non-selective	50-100%	June - July	Cut stems to two inches from the

						ground before applicati on

***Fallopia japonica* (Japanese Knotweed)**

Description

https://www.hortweek.com/network-rail-loses-japanese-knotweed-court-ruling/landscape/article/1486930

F. japonica is a non-native rhizomatous perennial that is a particularly difficult exotic species to manage. The stems emerge in early spring and grow tall, up to ten feet. The stems are reddish-brown and hollow, resembling bamboo. Heart-shaped leaves are large, growing four to seven inches in length. Clusters of small, greenish-yellow to white flowers are formed in July. Fruits mature in August or September, and are winged to increase seed dispersal.

The seeds rarely germinate, and North American knotweed is presumed to be a sterile male clone. It is still possible to produce viable seeds, usually through hybridization. F. japonica mainly spreads vegetatively, extending its massive woody rhizome system and sending up new shoots. Any piece of rhizome material moved to a new area can lead to new infestation. As such, it is generally contained in defined patches, and will not cross impervious surfaces like roads easily.

F. japonica offers no ecological benefits to native species other than dense cover. It can colonize a variety of ecosystems, swiftly converting them to monocultures, and degrading habitat value.

Non-chemical Treatment

Digging is an ineffective method of management, as *F. japonica* grows from a thick rhizome, forming large crowns that are extremely difficult to fully remove.

Mowing of *F. japonica* alone is not an effective means of control, and must be coupled with chemical treatment.

Small stands of *F. japonica* can be managed by mowing the area and covering it with impervious mats, thick enough that *F. japonica* is unable to grow through. Leaving the mats in place for several years will prevent the root system from sending up new shoots in the covered area, preventing photosynthesis. If in an area of full or partial sun, the heat will also damage the root system.

F. japonica is limited in its ability to spread across impervious surfaces, and will be more easily contained closer to roads.

Chemical Treatment

The most effective method of chemical treatment is first to mow *F. japonica* at the beginning of July, and follow with herbicide application. At least six weeks should pass between mowing and herbicide application, and when herbicide is applied the height of *F. japonica* is limited to its regrowth: three to four feet tall instead of six to ten feet tall.

Glyphosate can be applied as a foliar spray. Glyphosate is a non-selective herbicide, and patches with *F. japonica* are generally monocultures. Glyphosate should be applied twice in the first year of treatment, first in early August, and following up in September before the first frost.Grass can be seeded in the area if it is necessary for erosion control. As knotweed requires multiple years of treatment, an inexpensive annual rye grass would be optimal.

F. japonica can also be treated by stem injection, where herbicide is injected at the nodes, the location where the leaves meet the stem. Stem injection directs as much chemical as possible to the root system, but is labor intensive and requires specialized injection equipment.

F. japonica thrives in a range of soils, from sandy roadsides to moist wetlands. In wetland areas, use mechanical methods to the greatest extent feasible (such as thick mats). Work from the upstream seed source to downstream populations. If chemical treatment is used, care should be taken to use an herbicide that will not injure amphibian food sources and rare species such as Blanding's turtle. The table below provides guidance on using *Rodeo®.*

Application should not exceed the regulated rate per acre, of particular concern when filling hollow stems or injecting herbicide.

Herbicide should not be applied after the first frost, as *F. japonica* is frost sensitive and will die back, leaving any herbicides applied after frost unabsorbed.

Table 10. *F. japonica* Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Mowing					Aug; Sep	
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	2-4%[1]	Early Aug - Late Sep	Surfactant; first application: Add surfactant, must wait 6 weeks after early July mowing, second application: add surfactant, must be applied before first frost
Stem injection	Glyphosate	*Rodeo®*	Non-selective	100%	August	Injected at the stem nodes

Notes:
1. Contributed by BM

Convolvulus arvensis (Bindweed)

Description

https://www.swcoloradowildflowers.com/White%20Enlarged%20Photo%20Pages/convolvulus%20arvensis.htm

"Deep rooted perennial vine that grows along the ground until it comes in contact with other plants or structures; then climbs aggressively. Smooth, arrowhead-shaped leaves. Slender, twining stems that can grow to 6 feet long. Trumpet-shaped flowers, light pink to white. Two small leaf bracts about one inch below the flower. Fleshy pale roots that travel deeply and widely" https://www.nwcb.wa.gov

"Reproduces vegetatively from roots, rhizomes,stem fragments and by seeds that can lie dormant in the soil for up to 20 or more years. Roots spread widely underground, both vertically and horizontally, forming dense mats. Flowering is indeterminate, so flowers continue to develop along stems until the first frost" https://www.nwcb.wa.gov

Non-chemical Treatment

"Avoid digging or tilling the soil around mature field bindweed roots; roots or rhizome fragments left behind may resprout. Repeated hand pulling works eventually, but is highly labor intensive. It is best to limit hand pulling and tilling to seedlings; do in early spring when the ground is wet. Smothering plants with mulch, black plastic or plastic-fiber mats (geotextiles) is another option, but the covering must be kept in place for several years. Success may be somewhat limited as field bindweed can persist without light, sending its underground roots beyond the edge of the covering to start a new infestation. If using coverings, check often for cracks or openings; pull or spot spray any new growth coming up through the covering. Cutting alone will not control this plant and is not recommended." https://www.nwcb.wa.gov

Chemical Treatment

"Herbicides can be painted or brushed on leaves to avoid drift onto desirable plants. Products containing glyphosate are effective when applied in the summer and fall before

the leaves die back. However, glyphosate is “non-selective” and will injure any foliage that it comes in contact with including grass. Selective broadleaf herbicides with the active ingredients triclopyr and 2,4-D work well for lawn areas as they won’t harm most grasses. Repeat on regrowth as needed. All these herbicides are absorbed by foliage and moved throughout the plant to kill the roots and shoots. If retreating with glyphosate in the same season, allow plants to grow and produce flowers before each application.” https://www.nwcb.wa.gov

Table 11. *C. arvensis* Herbicide Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand-pulling					Mar - Sept	
Digging					Mar - Sept	
Mowing					Mar - Sept	
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	2%	July - Sept	
	Triclopyr	*Garlon® 3A*	Selective	3-5%		
	Imazapyr	*Habitat®*	Non-selective	2%		

Lythrum salicaria (Purple Loosestrife)

Description

L. salicaria is a non-native herbaceous perennial forb that is an aggressive invader of wetlands. Several four-sided square erect stems grow from a single plant, two to six feet in height. Leaves are opposite on the stem or in whorls around the base, and are smooth, elongated, and heart-shaped. Flower spikes are showy and magenta, made up of many small, five-petaled individual flowers, blooming late in the growing season. The fruit is a capsule developed in autumn containing small seeds.

https://www.minnesotawildflowers.info/flower/purple-loosestrife

L. salicaria is spread by seed, which are viable for many years, and remain dormant in the soil until conditions are right for growth.

L. salicaria can dominate areas where it is introduced, displacing native species and reduces biodiversity. *L. salicaria* also degrades wetlands, catching sediment that fills in wetlands, leading to reduced water flow, and decreased flood retention.

Non-chemical Treatment

L. salicaria populations can be partially managed by pulling and digging as long as the entire taproot is removed. This is time consuming and labor intensive, and should only be implemented on small pioneer populations that can be removed efficiently.

Biological control is the best method for long term large scale. Insect species can be introduced to feed on the plants, preventing *L. salicaria* from seeding and weakening, eventually destroying the plant.

Chemical Treatment

L. salicaria most commonly is found in sensitive wetland areas. The two most effective herbicides are glyphosate and triclopyr. Glyphosate and triclopyr amine, both registered for aquatic use, are commonly applied when managing *L. salicaria*. Treatment should occur prior to seed set to prevent future spread of the species.

Glyphosate can damage surrounding grasses and sedges, leaving new opportunities for colonization by *L. salicaria*. Pesticide should be selected based on density of the stands being treated, and whether or not surrounding plants are desirable. If surrounding plants are desirable grasses and sedges, triclopyr amine should be selected. If there are many exotic plants, glyphosate should be used, or a mixture of glyphosate and triclopyr. Follow up treatments will be required for years until the seedbank is depleted.

Table 12. *L. salicaria* Herbicide Treatment Guide

Application Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand pulling					Apr - Sep	
Digging					Apr - Sep	
Cutting					Apr - Sep	
Biological					Apr - Jun	Introduced insect species to feed on plant
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	1-2%	Late Aug	Apply after peak bloom; cut and dispose of flower heads prior to application
	Triclopyr amine	*Garlon® 3A*	Selective	1%		
Hand wicking					Late Aug	

***Rosa multiflora* (Multiflora Rose)**

Description

R. multiflora is a thorny non-native perennial shrub. The plants is tolerant of many conditions and can grow ten feet tall and ten feet wide. Stems are long, green to brown, with hooked thorns that make hand removal hazardous. Leaves are opposite with five to eleven leaflets, and leaflets are one to two inches in length. White to pinkish five petal flowers form in clusters in the summer. The plant produces bright red fleshy fruits (hips).

https://production.wordpress.uconn.edu/cipwg/wp-content/uploads/sites/244/2014/04/RobRoutledgeSaultCollegeBugwood.jpg

R. multiflora can generate new stems to spread, but it is predominantly spread by seed.

R. multiflora is easily distinguished from native *Rosa* species. In R. multiflora the base of leaf where it is attached to the thorny stem is fringed, and the plant's white to pinkish five petalled flowers occur in branched structures.

Benefits of the plant include the food and cover it provides to native animals. However, the overall effect this shrub has on habitat value is negative. *R. multiflora* crowds out native species and creates dense, impenetrable stands. *R. multiflora* can also act almost as a vine, and choke out native trees.

Non-chemical Treatment

Controlling small populations is much easier than attempting control dense stands. Hand pulling can be effective if the entire root of the plant is removed.

Cutting or mowing alone will not control *R. multiflora*, but are useful in preparation for herbicide treatment. Cut stem application would be impossible on dense stands, so mowing leads to better control.

Chemical Treatment

Foliar applications are made in summer when *R. multiflora* is flowering, with peak bloom being in early June. Spray should thoroughly cover the foliage of the plant, wetting as many leaves as possible without dripping. Glyphosate is less effective on multiflora rose than other herbicides but may be desirable if soil activity is a concern, or to avoid damaging surrounding grasses. Triclopyr can be applied as a foliar spray, and will eliminate top growth; future applications may be necessary to destroy the root system.

Triclopyr can also be applied to cut stems or as basal bark, and is most effective when applied in the dormant season. Cut stem use when mowing or cutting is practical; remove the top growth of the shrub and wet the stubble. This method can be applied year round. Basal bark is only feasible when the base of the plant can be accessed. It is best applied from January to autumn color. Wet the lower twelve inches of plant stem without causing runoff.

Table 13. *R. multiflora* Treatment Guide

Method	Herbicide	Brand	Selectivity	Concentration	Time	Notes
Non-chemical Treatment						
Hand pulling					Mar - Nov	Remove entire root
Cutting/Mowing					Mar - Nov	Effective when followed immediately by chemical treatment
Chemical Treatment						
Foliar spray	Glyphosate	*Rodeo®*	Non-selective	2%	May - Jun	
	Triclopyr	*Garlon® 3A*, *Garlon® 4 Ultra*	Selective	1%		
Cut stump/stem	Triclopyr	*Garlon® 3A*, *Garlon®*	Selective	50%	Year round	

		4 Ultra				
Basal bark	Triclopyr ester	*Garlon® 4 Ultra*	Selective	20-25%	Jan - Aug	Basal oil

Important Note: *Mention of specific products in this document does not constitute endorsement. Specific product names are mentioned in the resources used to create this document. This document is meant to serve as a guideline for exotic plant management, and is not a legal authority. By law, pesticides must be applied according to their labeling.*

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20. *Black Swallow-Wort (Vincetoxicum nigrum) Control Fact Sheet*, University of Rhode Island "http://www2.cambridgema.gov/CityOfCambridge_Content/documents/blackSwallowwort.pdf"

21. *Black Swallow-wort & Pale Swallow-wort*, Massachusetts Audubon Society "https://www.massaudubon.org/learn/nature-wildlife/invasive-plants/swallow-wort"

22. *Pest Management – Invasive Plant Control: Black Swallow-Wort*, Natural Resources Conservation Center "https://efotg.sc.egov.usda.gov/references/public/MN/797SwallowWort..pdf"

23. *Managing Japanese Knotweed*, Pennsylvania State University "https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_017951.pdf"

24. *Japanese knotweed (Fallopia japonica)*, Pennsylvania State University "http://plantscience.psu.edu/research/labs/weed-ecology/research/wildland-weed-management/publications/invasive-species-quicksheets/knotweed"

25. *Japanese Knotweed (Fallopia japonica): Best Management Practices in Ontario*, Ontario Invasive Plant Council "https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/06/OIPC_BMP_JapaneseKnotweed.pdf"

26. *Invasive Plants in Pennsylvania: Glossy Buckthorn (Frangula alnus)*, Pennsylvania Department of Conservation & Natural Resources "http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_010272.pdf"

27. *INVASIVE PLANT MANAGEMENT REPORT: SENEY NATIONAL WILDLIFE REFUGE (2017)* Corace, G., United States Fish & Wildlife Service "https://www.fws.gov/uploadedFiles/Invasive_Plant_Mgmt_Report_SeneyNWR.pdf"

28. *Imazapyr Chemical Fact Sheet, Wisconsin Department of Natural Resources*, Wisconsin Department of Natural Resources "https://dnr.wi.gov/lakes/plants/factsheets/ImazapyrFactsheet.pdf"

29. *Imazapyr: Review for Use in Lakes & Ponds in Massachusetts*, Massachusetts Department of Environmental Protection; Massachusetts Department of Agricultural Resources "https://www.mass.gov/files/documents/2016/08/ox/imazapyr.pdf"

30. KING COUNTY NOXIOUS WEED CONTROL PROGRAM WEED ALERT: Field Bindweed (aka Morning Glory) "https://www.nwcb.wa.gov/pdfs/Bindweed_factsheet_King.pdf"

Scott, Kelsey

To: Quiggle, Robert
Subject: RE: Lowell Heritage State Park information

From: Quiggle, Robert
Sent: Friday, December 20, 2019 3:28 PM
To: Harris, Jeffrey (DCR) <jeffrey.harris@state.ma.us>
Cc: Scott, Kelsey <Kelsey.Scott@hdrinc.com>
Subject: RE: Lowell Heritage State Park information

Jeffrey:

It was good to meet you this week, and thanks for providing this information so quickly. We'll look through this and let you know if we have additional questions, etc.

Have a great holiday,

Robert Quiggle, RPA
Regulatory and Environmental Section Manager

HDR
1304 Buckley Road, Suite 202
Syracuse, New York 13212-4311
D 315.414.2216 **M** 724.989.1579
Robert.Quiggle@hdrinc.com

hdrinc.com/follow-us

From: Harris, Jeffrey (DCR) [mailto:jeffrey.harris@state.ma.us]
Sent: Friday, December 20, 2019 12:33 PM
To: Quiggle, Robert <Robert.Quiggle@hdrinc.com>
Subject: Lowell Heritage State Park information

Rob-

Thank you for your presentation on the Boott Hydro relicensing project on Wednesday. As a follow-up, I wanted to provide you with some additional information that may be helpful in the various studies that are planned.

The first is a 2014 Resource Management Plan for the broader complex that includes Lowell Heritage State Park. This addresses DCR ownership, recreation, and other issues within the park. The document is available here: https://www.mass.gov/service-details/lowell-great-brook-planning-unit

Secondly, our GIS team undertook a major effort a number of years ago to clarify DCR ownership of parcels within the City of Lowell. This data is currently available through Mass GIS: https://docs.digital.mass.gov/dataset/massgis-data-protected-and-recreational-openspace

Let me know if you have any questions!

Jeffrey

Jeffrey Harris, Preservation Planner

Office of Cultural Resources
Department of Conservation and Recreation
251 Causeway Street - Suite 700
Boston, MA 02114
P: 617-626-4936
F: 617-626-1349

DCR's Office of Cultural Resources

Protecting the legacy and experience of history in Massachusetts state parks.

Scott, Kelsey

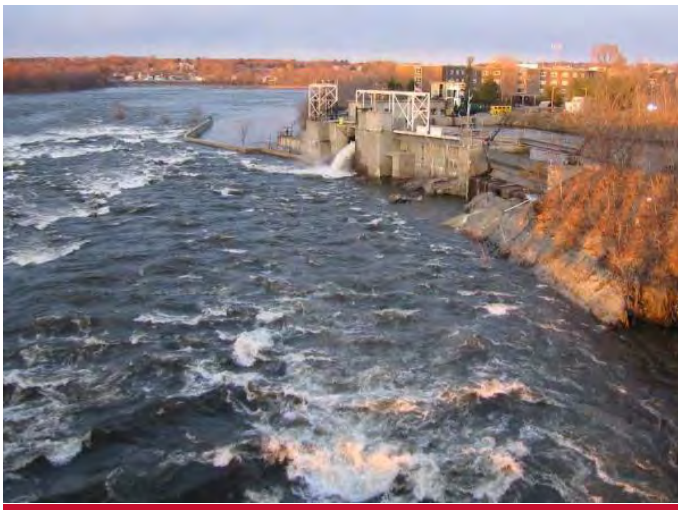
From: Bruins, Christine A <Christine_Bruins@nps.gov>
Sent: Friday, March 13, 2020 2:13 PM
To: Quiggle, Robert
Cc: Scott, Kelsey; Jones, Scott
Subject: Re: [EXTERNAL] Lowell Hydro Relicensing Waterborne Trash Mapping

The COVID 19 situation is evolving rapidly. I don't think we can realistically schedule something this month. Let's set a tentative date 30+ days out? Week of 4/20? Monday, Thursday, Friday are free.

Christine Bruins | Community Planner
Lowell National Historical Park
978.275.1726 (office) | 978.954.1011 (cell)

From: Quiggle, Robert
Sent: Friday, March 13, 2020 12:03 PM
To: Bruins, Christine A
Cc: Scott, Kelsey ; Jones, Scott
Subject: [EXTERNAL] Lowell Hydro Relicensing Waterborne Trash Mapping
Christine: We are looking to schedule our waterborne trash survey and mapping, and I wanted to check in with you to see if there were any specific dates that we should target or avoid. We'd like to get the fieldwork completed before mid-April, and we'd like to meet briefly with NPS staff that may have relevant information on waterborne trash issues while we're at the project.
We can be pretty flexible in terms of scheduling the fieldwork, but just let us know what makes sense on your end.
Thanks,
Robert Quiggle, RPA
Regulatory and Environmental Section Manager

HDR
1304 Buckley Road, Suite 202
Syracuse, New York 13212-4311
D 315.414.2216 **M** 724.989.1579
Robert.Quiggle@hdrinc.com



Water Level and Flow Effects on Historic Resources Study Report

Lowell Hydroelectric Project (FERC No. 2790)

February 25, 2021

Prepared by:

HDR

Prepared for:

Boott Hydropower, LLC
Manchester, New Hampshire

Central Rivers Power

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Contents

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List of Acronyms

Boott	Boott Hydropower, LLC (or Licensee)
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
FERC	Federal Energy Regulatory Commission (or Commission)
ft	feet
ILP	Integrated Licensing Process
ISR	Initial Study Report
LNHP	Lowell National Historical Park
MADCR	Massachusetts Department of Conservation and Recreation
MW	megawatt
NGVD 29	National Geodetic Vertical Datum 1929
NHL	National Historic Landmark
NOI	Notice of Intent
NPS	National Park Service
PAD	Pre-Application Document
Project	Lowell Hydroelectric Project (or Lowell Project)
PSP	Proposed Study Plan
RL	river left
RM	river mile
ROR	run-of-river
RR	river right
RSP	Revised Study Plan
SD1	Scoping Document 1
SPD	Study Plan Determination
USDOI	U. S. Department of Interior

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1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20.2-megawatt (MW) Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

In accordance with 18 C.F.R. § 5.15, Boott has conducted studies as provided in the study plan and schedule approved in the Commission's March 13, 2019 Study Plan Determination (SPD) for the Project.[1] This report describes the methods and results of the approved Water Level and Flow Effects on Historic Resources Study conducted in support of a new license for the Project.

1.1 Project Description and Background

The Lowell Project is located at river mile (RM) 41 on the Merrimack River in the City of Lowell in Middlesex County, Massachusetts, with a headpond extending approximately 23 miles upstream into Hillsborough County, New Hampshire. The existing Lowell Project consists of:

1) A 1,093-foot-long, 15-foot-high masonry gravity dam (Pawtucket Dam) that includes a 982.5-foot-long spillway with a crest elevation of 87.2 feet (ft) National Geodetic Vertical Datum 1929 (NGVD 29) topped by 5-foot-high pneumatically-operated crest gates deployed in five independently-operable zones;
2) A 720-acre headpond with a normal maximum water surface elevation of 92.2 ft NGVD 29;
3) A 5.5-mile-long canal system which includes several small dams and gatehouses;
4) A powerhouse (E.L. Field) which uses water from the Northern Canal and contains two turbine-generator units with a total installed capacity of 15.0 MW;
5) A 440-foot-long tailrace channel;
6) Four powerhouses (Assets, Bridge Street, Hamilton, and John Street) housed in nineteenth century mill buildings along the Northern and Pawtucket Canal systems containing 15 turbine-generator units with a total installed capacity of approximately 5.1 MW;
7) A 4.5-mile-long, 13.8-kilovolt transmission line connecting the powerhouses to the regional distribution grid;

[1] The Commission issued a Revised Process Plan and Schedule on June 12, 2020.

8) Upstream and downstream fish passage facilities including a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam; and

9) Appurtenant facilities.

At the normal pond elevation of 92.2 ft NGVD 29[2] (crest of the pneumatic flashboards), the surface area of the headpond encompasses an area of approximately 720 acres. The gross storage capacity between the normal surface elevation of 92.2 ft and the minimum pond level of 87.2 ft is approximately 3,600 acre-ft. The Project operates essentially in a run-of-river (ROR) mode using automatic pond level control and has no usable storage capacity.

The Project's primary features are located along the Merrimack River in the City of Lowell, Massachusetts. The City of Lowell was founded in the early 1820s by Boston merchant capitalists and became one of the most significant planned industrial cities in America (Hay 1991). Lowell's factory system, which used the waterpower of the Merrimack River, incorporated new technologies to provide for the mass production of cotton cloth in mills throughout the city (National Park Service [NPS] 1981). Lowell established the pattern for large-scale waterpower development for the next 50 years (Hay 1991).

Several Project facilities are located within overlapping locally, state, and nationally designated parks and historic properties and/or preservation districts. The Project's Pawtucket Dam and E.L. Field Powerhouse are located along the mainstem of the Merrimack River. The Project's two-tiered network of man-made canals extends throughout downtown Lowell. The 5.5-mile-long canal system provides flow to the Project's Hamilton, Assets, Bridge Street, and John Street developments. The Hamilton, Assets, Bridge Street, and John Street power stations and turbines are housed in large former mill buildings. The mill buildings are not included in the Project; the Project Boundary includes only the turbines and associated equipment at these downtown mill sites. In addition to the Pawtucket Dam and hydroelectric developments, the Project also includes miscellaneous civil works in the City of Lowell, including the Guard Lock and Gates, Moody Street Feeder Gatehouse, Lawrence Dam, Hall Street Dam, Tremont Wasteway, Lower Locks and Dam, Swamp Locks and Dam, Merrimack Dam and Merrimack Gate, Rolling Dam, and the Boott Dam.

The canal system, the downtown mill sites, and many of the Project's civil works, are contributing resources to Lowell Locks and Canals National Historic Landmark (NHL) District. The canal system and many Project facilities are also located within the Lowell National Historical Park (LNHP) managed by the NPS and the larger Lowell Historic Preservation District. The LNHP was established by Congress in 1978 to "preserve and interpret the nationally significant historical and cultural sites, structures, and districts in Lowell, Massachusetts, for the benefit and inspiration of present and future generations." The park is by design a partnership park in which federal, state, and local governments as

[2] Elevations throughout this study are reported or have been converted to the National Geodetic Vertical Datum 1929 (NGVD 29).

well as the private sector and local community carry out the legislative intent of the park unit. The Lowell National Historical Park is also listed on the National Register of Historic Places, and certain properties within the park overlap with properties in the NHL District.

The Lowell Heritage State Park, established in 1974 as a precursor to the LNHP, is also located within the City of Lowell and is comprised of linear greenways along the Merrimack River and canal system and a collection of historic buildings and structures related to the industrial development of the city. These buildings and structures include Project features and properties located within the NHL District. The Lowell Heritage State Park is operated by the Massachusetts Department of Conservation and Recreation (MADCR) and features exhibits created in partnership with the NPS (MADCR 2018). With the exception of the Rynne Bathhouse, all of the built resources within the Lowell Heritage State Park fall within the Lowell Historic District, designated by the City of Lowell to "…ensure that development activities within the district are consistent with the preservation of its 19th century setting" (MADCR 2014). Portions of the Lowell Heritage State Park also overlap with the Lowell Locks and Canals NHL District and the LNHP.

1.2 Study Development

On April 30, 2018, Boott initiated the ILP by filing a Pre-Application Document (PAD) and Notice of Intent (NOI) with the Commission. Major ILP milestones to-date are presented in Table 1-1.

Table 1-1. Major ILP Milestones Completed

Date	Milestone
April 30, 2018	PAD and NOI Filed
June 15, 2018	Scoping Document 1 (SD1) Issued by FERC
July 17, 2018	FERC Agency and Public Scoping Meetings Conducted
July 18, 2018	Project Site Visit Held
September 27, 2018	Scoping Document 2 (SD2) Issued by FERC
September 28, 2018	Proposed Study Plan (PSP) Filed
October 18 & 19, 2018	PSP Meeting Conducted
January 28, 2019	Revised Study Plan (RSP) Filed
March 13, 2019	FERC Issued SPD
February 25, 2020	Initial Study Report (ISR) Filed
March 11, 2020	ISR Meeting
June 12, 2020	FERC Issued Revised Process Plan and Schedule

Boott has continued consultation with stakeholders regarding the approved studies as required by the Commission's SPD. In accordance with the schedule presented in the

Revised Study Plan (RSP), Boott has also provided stakeholders with Quarterly ILP Study Progress Reports that include a description of study activities conducted during the previous quarter, activities expected to occur in the next quarter, and identified variances from the approved study plan.

The NPS previously indicated that changing water levels and flows in the Project's canal system have the potential to adversely affect historic canal structures. To document water levels under a range of operating conditions, Boott deployed pressure transducers (level loggers) in the canal system to record water level fluctuations at 15-minute intervals. By letter dated May 5, 2019, Boott consulted with the NPS regarding the specific locations for level logger deployment. In June 2019, level loggers were deployed at 10 locations in the canal system. Data from the level loggers were downloaded on an approximate monthly basis.

On December 18, 2019, Boott held a Study Workshop to discuss the Water Level and Flow Effects Study; Recreation and Aesthetics Study; Historically Significant Waterpower Equipment Study; and the Resources, Ownership, Boundaries, and Land Rights Study. During the workshop, the NPS clarified that their interest was related to the effects of the Pawtucket Dam pneumatic crest gate system that became operational in 2018. The NPS was concerned that the new pneumatic crest gate could increase flows to the downtown canal system and that higher flows could have the potential to adversely affect historic structures. During the December 18, 2019 Study Workshop, Boott explained that water levels in the downtown canal system are not affected by the crest gate and that any effects would be limited to structures along the Northern Canal and the Upper Pawtucket Canal (extending upstream from the Guard Lock Gate Complex to the mainstem of the Merrimack River). Given that water levels in the downtown canal system are not affected by crest gate operations, the NPS agreed that the historic resources along the Northern Canal and Upper Pawtucket Canal should be the focus of the Water Level and Flow Effects Study. Therefore, the NPS and Boott agreed that Boott should relocate level loggers to the Upper Pawtucket Canal and Northern Canal and remove the remaining level loggers from the downtown canal system. Boott relocated the level loggers in March 2020 and recorded water level fluctuations in the Upper Pawtucket Canal and Northern Canal in 15-minute intervals through late September 2020. During the 2020 deployment period, Boott recorded a wide range of flows in the Upper Pawtucket Canal and Northern Canal, including high flow events during the spring freshet and low flow events during the summer and early fall of 2020. Boott believes that this range of flows is appropriate to analyze potential Project-related water level and flow effects on historic structures in the Upper Pawtucket and Northern canals. Boott utilized the level logger data from the 2020 deployment period, Project operation data, existing drawings, and field observations to assess potential effects.

2 Study Goals and Objectives

The goal of this study is to assess the potential effect of water level fluctuations within the headpond, Northern Canal, and the Pawtucket Canal (extending upstream from the Guard

Lock Gate Complex to the mainstem of the Merrimack River) on the historic structures including the Pawtucket Gatehouse, the Waste Gate Building, the Guard Lock Gate Complex structures, and the Great Wall. The specific objectives of this study are as follows:

- Evaluate how Project operations, including manipulation of the new crest gate system, canal head gates, spillways, locks, fish passage structures, and generating units will change water levels in the Upper Pawtucket and Northern Canals;
- Determine the extent to which water flows or elevations are having an effect on historic resources;
- Conduct a structural assessment of the Great River Wall; and
- Identify potential impacts of current Project operations on nationally significant historic resources, including a structural assessment of the Great River Wall.

3 Study Area

In accordance with the Commission's SPD, the study area for the Water Level and Flow Effects on Historic Resources includes the Projects canal system and associated Project infrastructure within the FERC Project Boundary in the City of Lowell, limited to the Northern Canal from the canal headworks to the E.L. Field Powerhouse not including the portion of the Northern Canal downstream of the Hydro Locks. Also included in the study area is the Upper Pawtucket Canal from the confluence with the Merrimac River downstream to the Guard Lock Gate Complex (Figure 3-1) and the portion of the Project headpond in the proximity of the Pawtucket Dam.

Figure 3-1. Study Area.

4 Methodology

4.1 Document Review of Existing Conditions

Boott reviewed available architectural and engineering evaluations of historic canal structures available from the NPS and other stakeholders, including documentation of previous maintenance and repairs to characterize existing conditions. Based on this document review, Boott identified properties that have previously been affected by water level or flow conditions. Copies of these documents are included in Appendix A of this study report.

4.2 Site Visit to Document Existing Conditions

The approved Water Level and Flow Effects Study Plan directed Boott to conduct a site visit with the NPS, to identify locations where fluctuating water levels or flows have previously caused adverse effects to historic structures along the canal system. As proposed by Boott, the intention of this field visit was to collect additional information from NPS staff who may have observed or documented potential adverse effects associated with Project-related flows or water levels, and to identify specific structures (or components of structures) that are of interest to the NPS. However, due to the ongoing COVID-19 pandemic, Boott sought alternatives to in-person meetings and field visits to protect the health and safety of all parties.

Accordingly, Boott consulted with the NPS via letter dated January 4, 2021 regarding previously documented issues related to Project-related flow effects or changing water levels along the canal system. Boott sought the NPS's assistance in identifying historic canal structures along the Upper Pawtucket and Northern Canals that have purportedly been affected by Project-related water levels or flows. Specifically, Boott sought any records of previous damage, maintenance, or repairs to structures along the Upper Pawtucket or Northern canals that have resulted from Project-related flows or water levels. Boott requested the NPS's assistance in identifying any other known issues related to water levels and flow effects on specific structures along these canals.

Boott conducted a site visit to historic canal structures with input from NPS to identify issues previously noted by the NPS related to the flow and water levels on historic structures. Due to COVID-19 guidance and restrictions, the site visit was conducted by Boott independently. The site visit was conducted on January 27, 2020 by Boott to visually assess the effects of water level fluctuations on the historic structures associated with the Northern and Upper Pawtucket Canals and to collect additional data in support of this study.

NPS provided written comments on February 3, 2021 in response to Boott's request for information. Following receipt of that information from NPS, Boott performed an additional

data collection site visit on February 15, 2021 to collect additional elevation information for the historic structures detailed by NPS.

4.3 Canal Water Level Monitoring

To assess water levels under a range of operating conditions, Boott installed pressure transducers (level loggers) at four locations within the canal system that were identified in consultation with the NPS, and an additional atmospheric logger deployed near the E.L. Field Powerhouse (for calibration and barometric pressure correction).

The level loggers were installed on March 10, 2020 and were placed at a depth where they would remain below the water level during all field conditions during the study period. Accordingly, each installation established a sound, initial reference depth to which relative change (increase/decrease in water depth) was then recorded.

Additionally, each level logger was placed in an inconspicuous location on the channel bottom or tethered with weights to a non-movable object (i.e. rock, handrail, or tree). Each level logger recorded Kilopascal (kPa) pressure and Fahrenheit (°F) water temperature at 15-minute intervals. Pressure was converted to a relative sensor depth using Hoboware Pro™ software by Onset®, and the loggers have a stated operational range of 0 to 30 ft and an accuracy of ±0.03 ft.

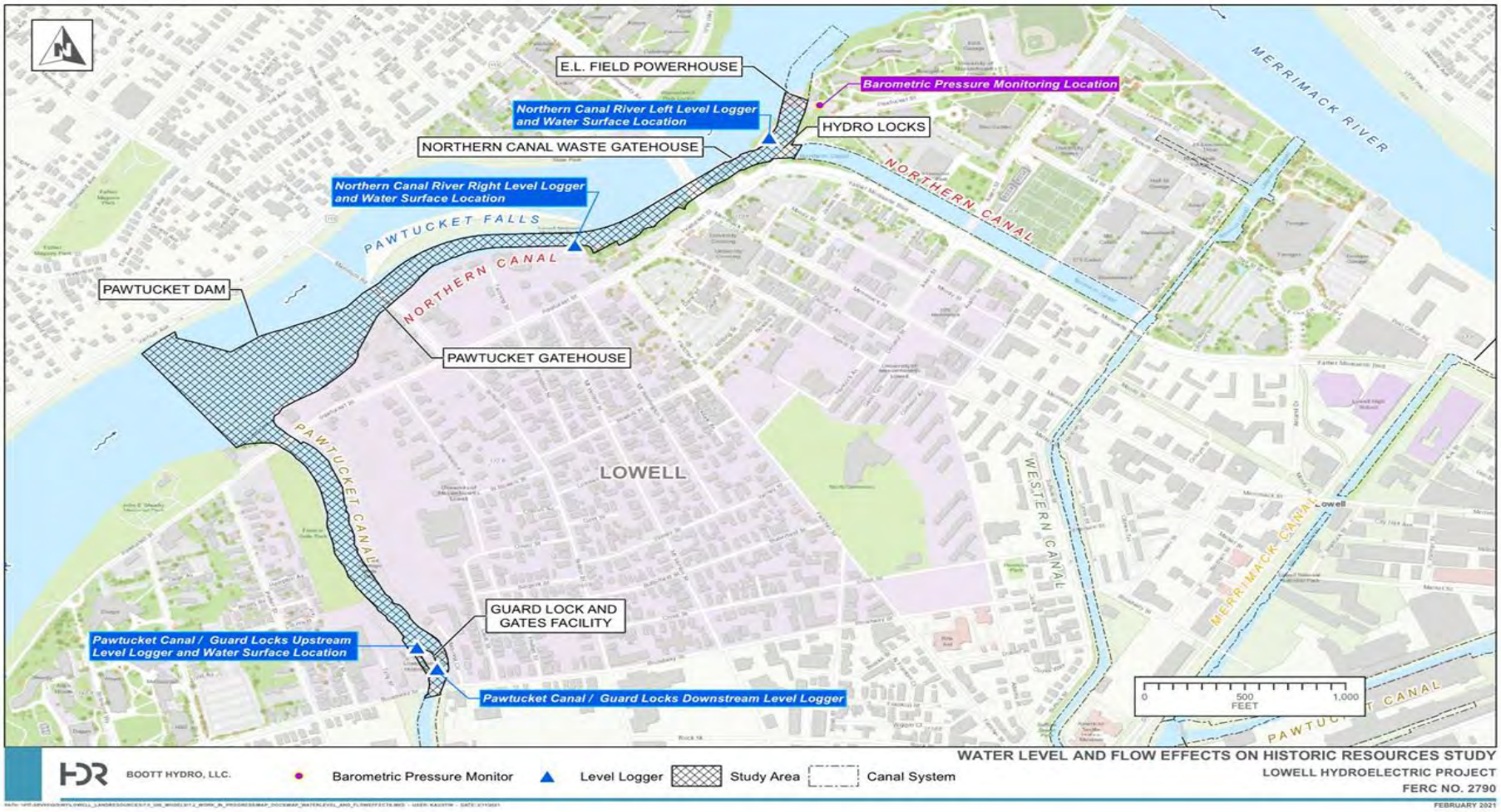
At the time of installation, and during each data download event, the vertical distance from the water surface (above each level logger) was measured to a temporary local fixed reference point ("local benchmark") which was used to correct any relative vertical change in level logger placement after data download events which occurred approximately monthly during the study period. Each local benchmark was then surveyed using an EOS Gold Global Positioning System with Real-Time Kinematic and sub-centimeter accuracy. Accordingly, the collected data was converted to an elevation which represents the elevation of the water surface at each location. This elevational data was then converted to the NGVD 29 using the National Oceanic and Atmospheric Administration's Vertical Datum Transformation tool (VDatum) to match the existing elevation data in Boott's Supervisory Control and Data Acquisition System (SCADA).

Level loggers were installed at 4 locations within the study area. Level logger locations are consistent with the areas of interest as identified by the NPS, with exact location within each area of interest determined by channel geometry, hydraulic conditions and field conditions.

A primary and backup level logger was installed at each location and recorded relative water depths at 15-minute intervals over the study period which extended from March 10 to September 23, 2020. Additionally, a single atmospheric logger was deployed within the study area at the E.L. Field Powerhouse to allow for calibration and barometric pressure correction. A total of nine instruments were deployed (eight in-water, and one atmospheric). The level logger locations include one location on the Northern Canal on river left (RL) adjacent to the Emergency Spillway Gate, a second location on the Northern Canal on river right (RR), near the intersection of Fletcher and Pawtucket Streets, and two

locations (one upstream and one downstream) on the Pawtucket Canal at the Guard Lock Gate Complex and are depicted in Figure 4-1 below.

Figure 4-1. Water Level and Flow Effects on Historic Resources Study Area



4.4 Project Operations Review

Boott reviewed Project operational data including headpond elevation, forebay elevation, Project operations, and Merrimack River flows. Boott then compared the results of these reviews to the water surface elevations recorded during the study periods, the elevations of historic structures and the existing conditions of those structures to determine the potential effect (if any) to the current conditions and expected conditions of such structures.

4.5 Structural Engineering Assessment of the Great River Wall

Boott conducted a structural engineering assessment of the Great River Wall, including review of available engineering and architectural drawings, maintenance records, photos and structural modifications. Due to lack of access, COVID-19 guidance, and travel restrictions, no site visit was performed for this portion of the study.

4.6 Analysis of Potential Project Related Effects

Boott analyzed the data collected in each of the five sections above to determine if and when Project operation flows into the canal system may have resulted in water levels reaching elevations to inundate wooden structural elements, or if periods of low flows may have caused damage to historic infrastructure.

5 Study Results

5.1 Documentation Review of Existing Conditions

Pursuant to the approved study plan, Boott reviewed several source documents to better understand the elevations of structures potentially effected by fluctuating water levels in the Northern and Upper Pawtucket Canals. The following list includes those documents reviewed[3].

- Proprietors Canal System Book of Facts.
- Supporting Technical Information Document – Guard Locks and Gates Facility (NATDAM No. MA 00834) Lowell Hydroelectric Project FERC No. 2790-MA Lowell, Massachusetts. 2015.
- Dam Safety Inspection Report for the Lowell Hydroelectric Project FERC No. 02790-MA.
- U. S. Department of Interior (USDOI) comments on the PAD, comments on SD1, and study requests dated August 14, 2018 regarding Boott Hydropower, LLC, Lowell

[3] Some documents referenced in this study report and included in this list are considered Critical Energy Infrastructure Information (CEII) by the FERC and are not for public distribution and are also not included in Appendix A of this study report.

Hydropower Project (FERC No. 2790-072), Merrimack River, Middlesex County, MA, and Hillsborough County, NH.

- USDOI Request for Information Response February 3, 2021 regarding requested Information in response to Central Rivers Power letter dated 01/20/2021, Lowell Hydropower Project (FERC No. 2790-072), Water Level and Flow Effects on Historic Resources Study.
- Lowell Hydroelectric Project (FERC No. 2790) Exhibit E and F Drawings obtained from the circa 1980 Application for License for Major Project.
- Lowell Heritage State Park Drawings for the Lowell Canal System circa 1983. Department of Environmental Management division of Forests and Parks.
- E.L. Field Powerhouse operational data including but not limited to project generation, project flow, headpond elevations, project inflow, project outflow, fishway operations, etc.
- Historic American Engineering Record, National Park Service, Louis R. Scurci, 1974.
- Pawtucket Gatehouse Facility Ex Condition Photographs, 2020
- Northern Canal – New Lock Gates: Plans, Elevation Details, and Hardware. August 1984.
- Francis Guard Gate Sluice Gatehouse Ex Condition Photographs, 2020
- LNHP, Rehabilitate Northern Canal Waste Gatehouse. 100% Construction Documents June 28, 2018
- LNHP, Rehabilitate Northern Canal Waste Gatehouse. LOWE-225866 Project Specifications Construction Documents. NPS, Northeast Region 100% Submission June 28, 2018
- Project Scoping Report. Task Order #P17PD03094; Contract #P15PC00036; PMIS #225866 Northern Canal Waste Gatehouse. November 13, 2017.
- Rehabilitate Northern Canal Waste Gatehouse. LNHP, Lowell, MA Estimate Class A February 2, 2018.

Boott reviewed the above listed data to identify elevations, conditions, and other relevant information regarding historical structures that may be potentially affected by project operations related to water level fluctuations in the project headpond, Northern Canal and Upper Pawtucket Canal. While many of these documents contain relevant information related to the conditions of relevant historic structures, there are few, if any details on the elevations of these structures in relation to water level fluctuation.

5.2 Canal Water Level Monitoring

As noted above, the objective of this study was to analyze the potential effects of water level fluctuations from project operations in the Northern Canal and the Upper Pawtucket Canal on historic structures with a focus on the Pawtucket Gatehouse, the Northern Canal Waste Gatehouse, the Guard Lock and Gatehouse Complex and the Great Wall.

The level loggers and associated elevation data captured a sufficient range of operational conditions (including spring freshet flows and summer low flows) over the course of the deployment period, to show a typical period of water surface elevation at each of the locations listed above. Additionally, the water surface elevations of the Project headpond and the Project forebay over the available period of record (1995 through 2010) allowed Boott to analyze the potential effects of water level fluctuations on historic structures in and along these canals.

5.2.1 E.L. Field Headpond/Northern Canal Lock

Water surface elevations within the Project headpond at the Northern Canal Lock during the study period (March 10 – September 29, 2020) range from a minimum of 91.76 ft to a maximum of 92.30 ft for a range of 0.54 ft (Figure 5-1).

Figure 5-2 shows the estimated elevations of the top and bottom sill of the Pawtucket Gatehouse Lock Gate relative to the water level of the Project headpond.

Figure 5-1. Project Headpond Water Surface Elevation During 2020 Monitoring Period

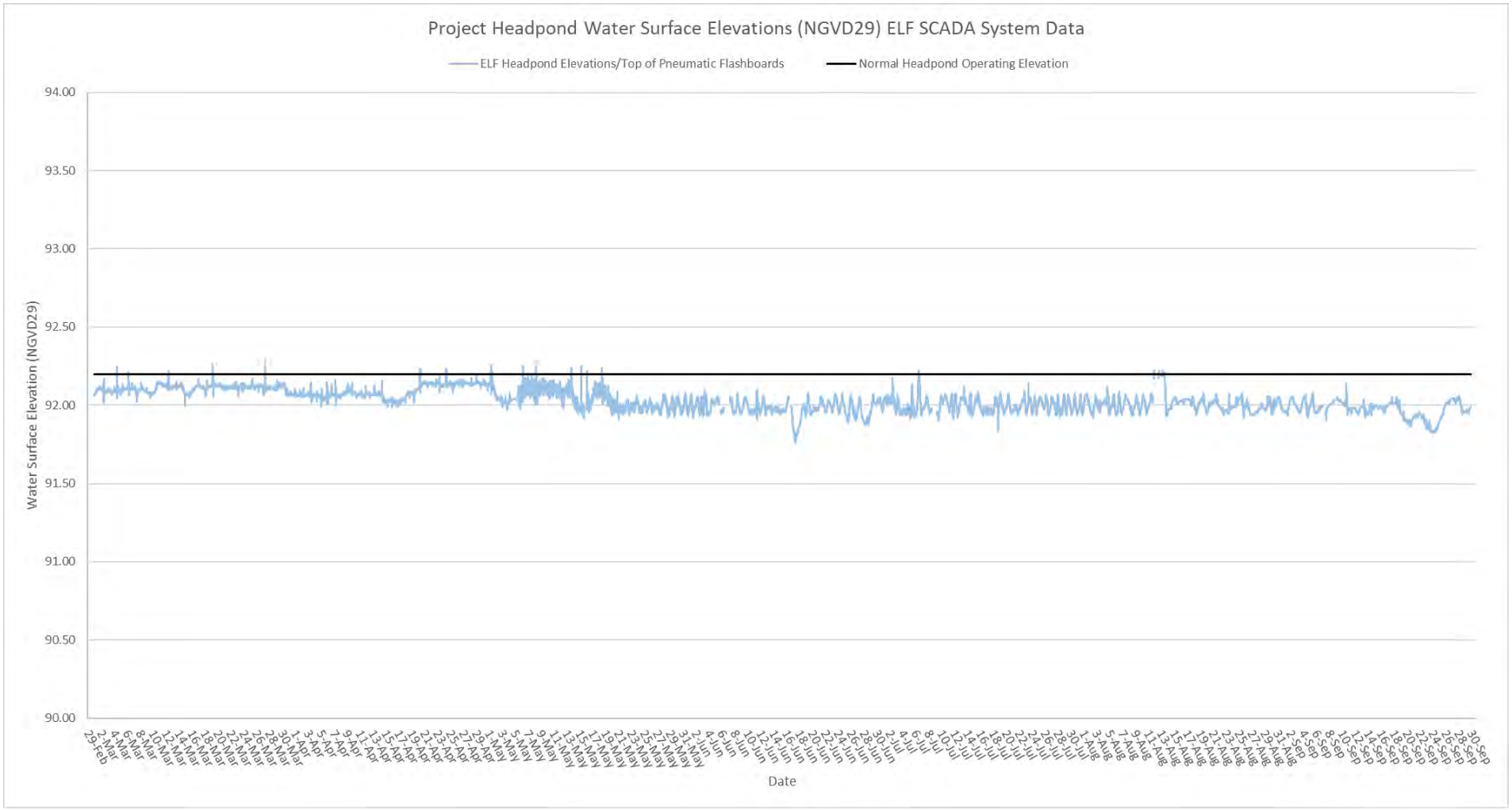
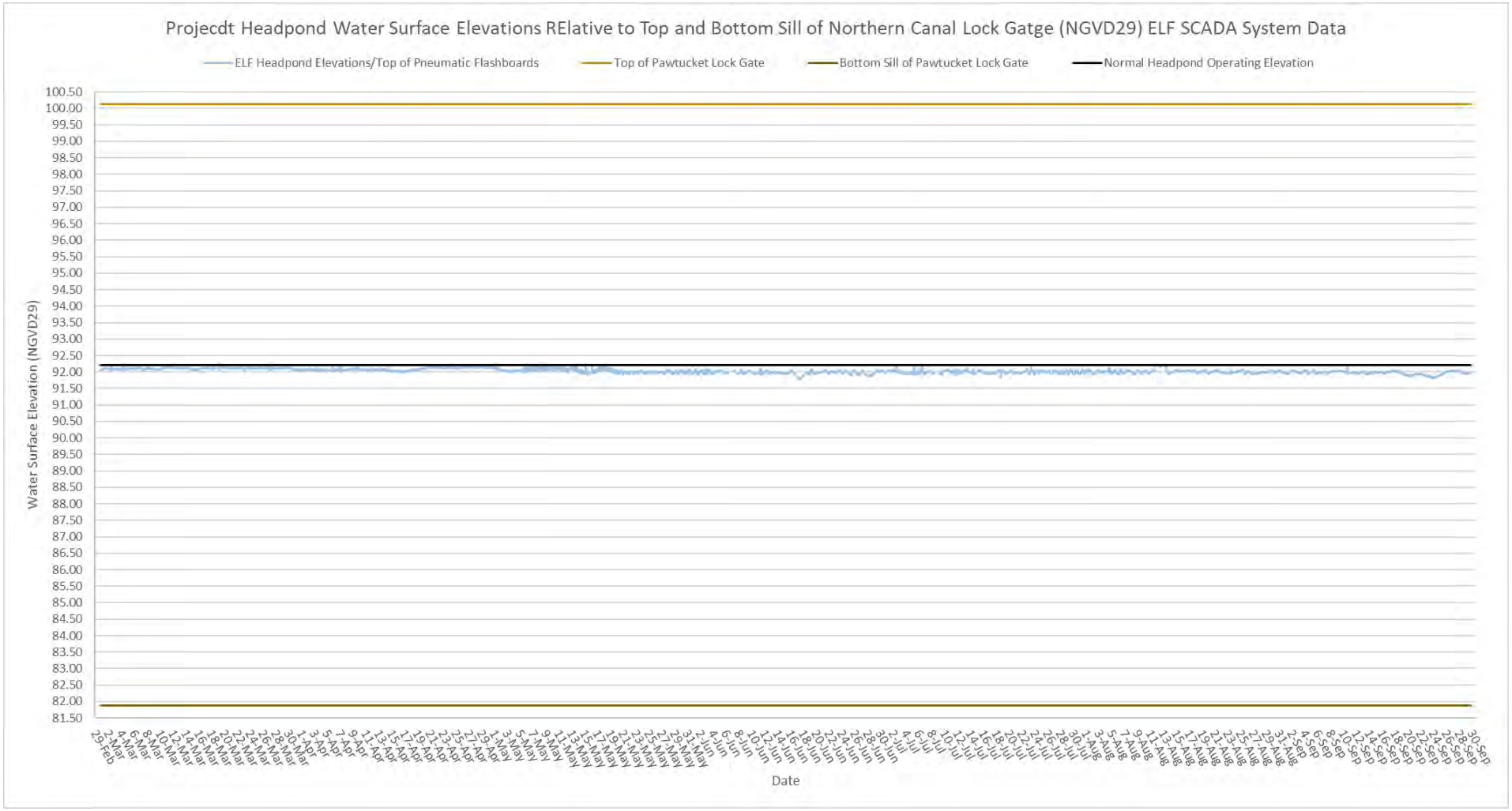


Figure 5-2. Project Headpond Water Surface Elevation During 2020 Monitoring Period Relative to Top and Bottom Sills of the Northern Canal Lock Gate



5.2.2 Northern Canal

Water surface elevations within the Northern Canal collected during the study period ranged from a minimum of 85.30 ft to a maximum of 91.64 ft (Figure 5-3) with a range of 6.34 ft at the Northern Canal River Left (RL) location near the Emergency Surge Gate and from a minimum of 85.71 ft to a maximum of 92.14 ft (Figure 5-4) for a range of 6.43 ft at the Northern Canal River Right (RR) location, near the canal's mid-point between the Pawtucket Gatehouse and the E.L. Field powerhouse.

Based on the level logger data collected in the Northern Canal at the RL location, water surface elevations within the Northern Canal reached elevations greater than 91.5 ft (the normal maximum operating elevation of the Northern Canal) on one occasion during the monitoring period. Beginning on August 11 at approximately 9:45 PM through August 13 at approximately 3:45 p.m. the water surface elevation in the Northern Canal was greater than 91.5 ft reaching a maximum elevation of 91.64 ft (Figure 5-3).

Based on the level logger data collected in the Northern Canal at the RR location, water surface elevations within the Northern Canal reached elevations greater than 91.5 ft (the normal maximum operating elevation of the Northern Canal) on three occasions. On March 19 at approximately 9:00 a.m. the water surface reached a maximum elevation of 91.52 ft for less than 15 minutes. On May 15 at the RR location, the water surface elevation within the Northern Canal rose above 91.5 ft for approximately 10 hours and reached a maximum elevation of 91.62 ft. Beginning on August 11 at approximately 9:45 p.m. through August 13 at approximately 3:45 p.m. the water surface elevation in the Northern Canal at the RR location was greater than 91.5 ft reaching a maximum elevation of 91.64 ft (Figure 5-4).

Figure 5-3. Northern Canal River Left Location - Water Surface Elevation During 2020 Monitoring Period

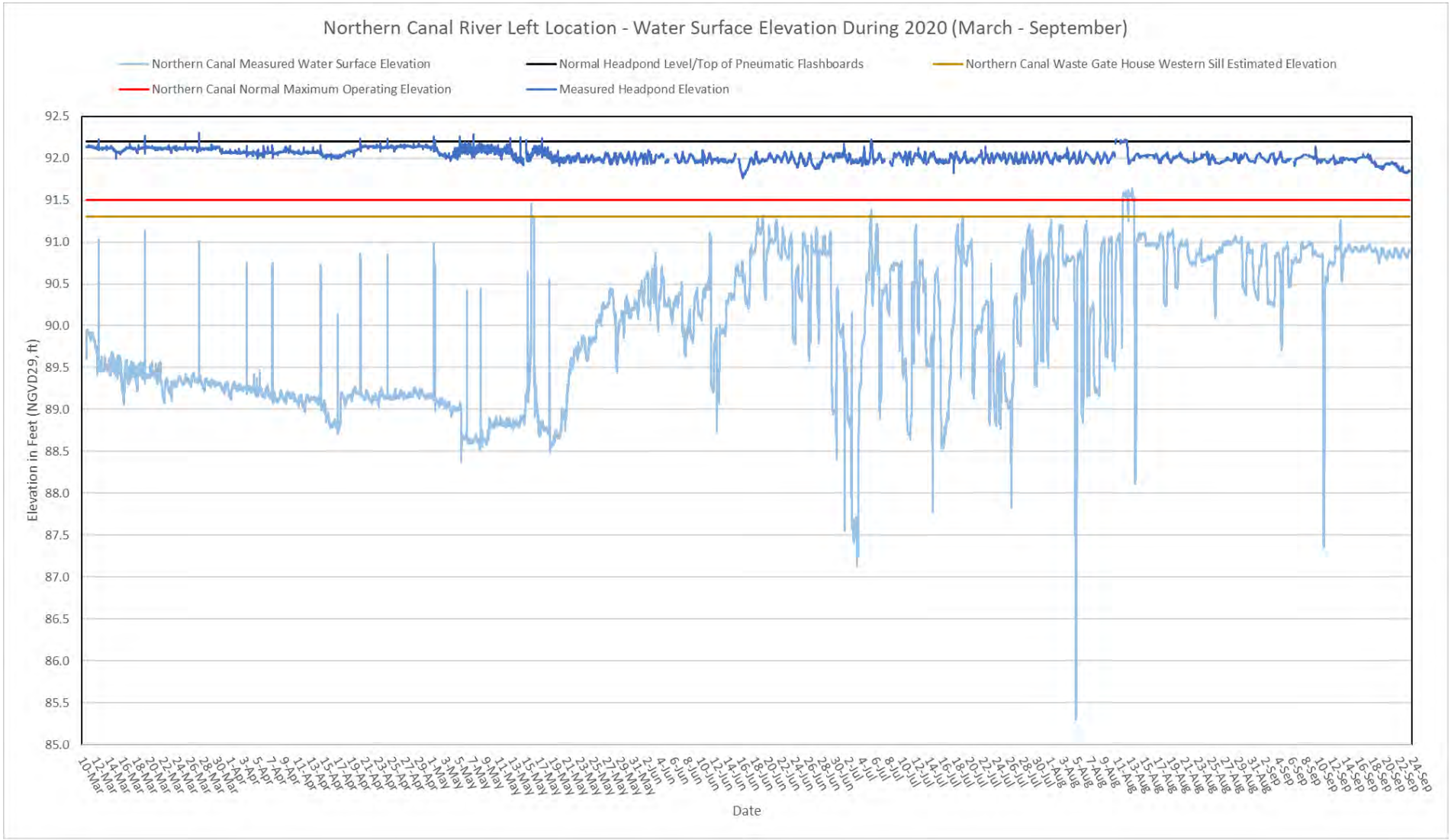
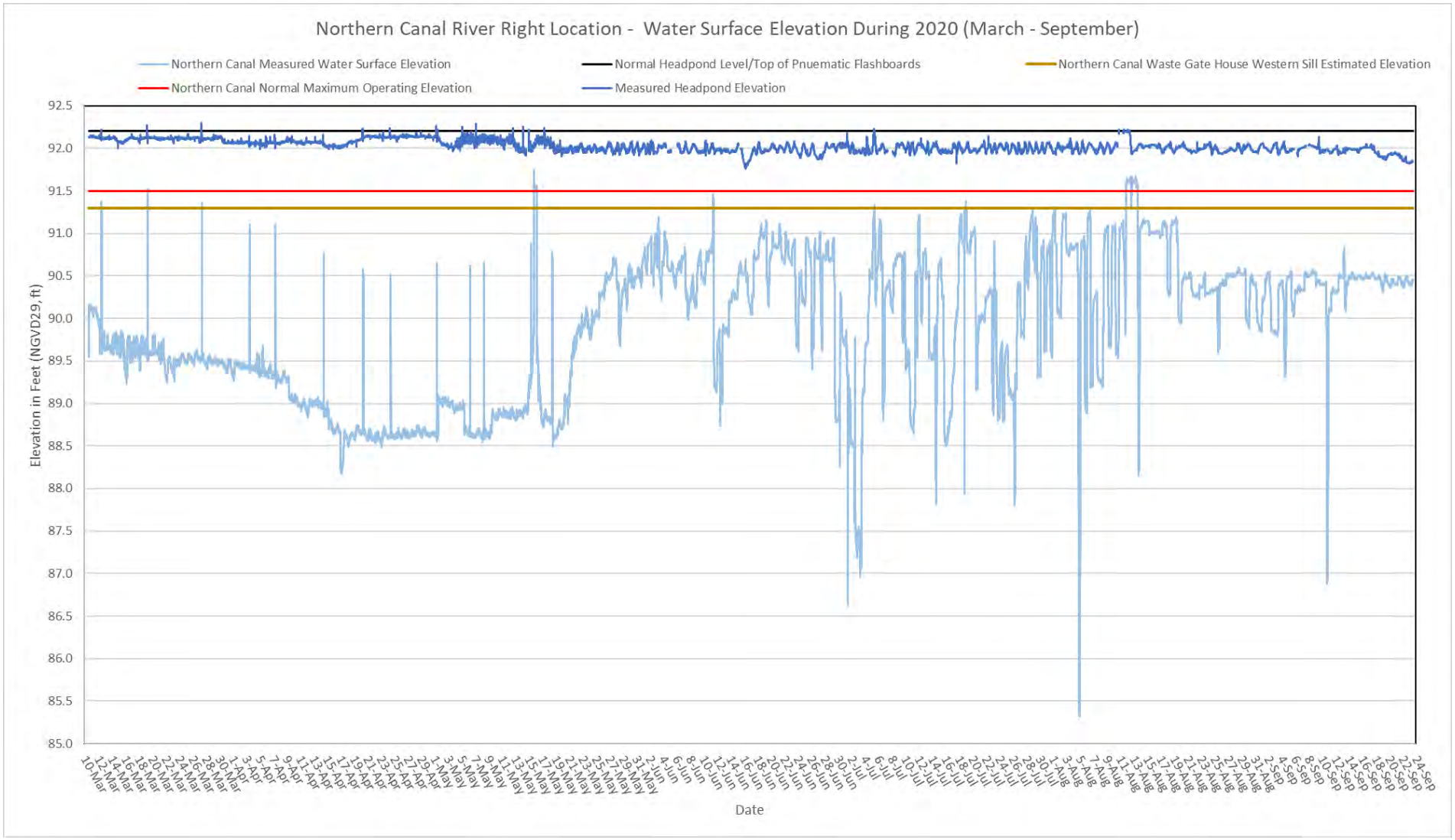


Figure 5-4. Northern Canal River Right Location - Water Surface Elevation During 2020 Monitoring Period. Pawtucket Canal



5.2.3 Upper Pawtucket Canal

Water surface elevations within the Upper Pawtucket Canal during the study period ranged from a minimum of 91.69 ft to a maximum of 92.35 ft (Figure 5-5) for a maximum range of 0.66 ft, and are consistent with the impoundment level data. Within the Lower Pawtucket Canal levels ranged from a minimum of 79.53 ft to a maximum of 86.21 ft (Figure 5-6) for a range of 6.68 ft. Water surface elevation data downstream of the Guard Lock Gate Complex were not collected following the June 12 download event due to loss of the downstream level loggers (Lower Pawtucket Canal). These loggers were not recovered nor replaced.

On one occasion during the study period, the water surface elevation within the Upper Pawtucket Canal reached an elevation greater than 92.2 ft (the normal operating elevation of the Project headpond). This event occurred from March 27 at approximately 11:30 a.m. and lasted for less than 15 minutes, reaching a maximum elevation of 92.29 ft.

The Lower Pawtucket Canal was drawn down approximately 6.5 ft from April 2 through April 7, 2020 to facilitate bridge reconstruction in downtown Lowell, but generally remained between elevations 88.25 ft and 89.47 ft, a range of 1.22 ft during the remaining study period.

Figure 5-5. 2020 Upper Pawtucket Canal Water Surface Elevation (March 10 - September 24)

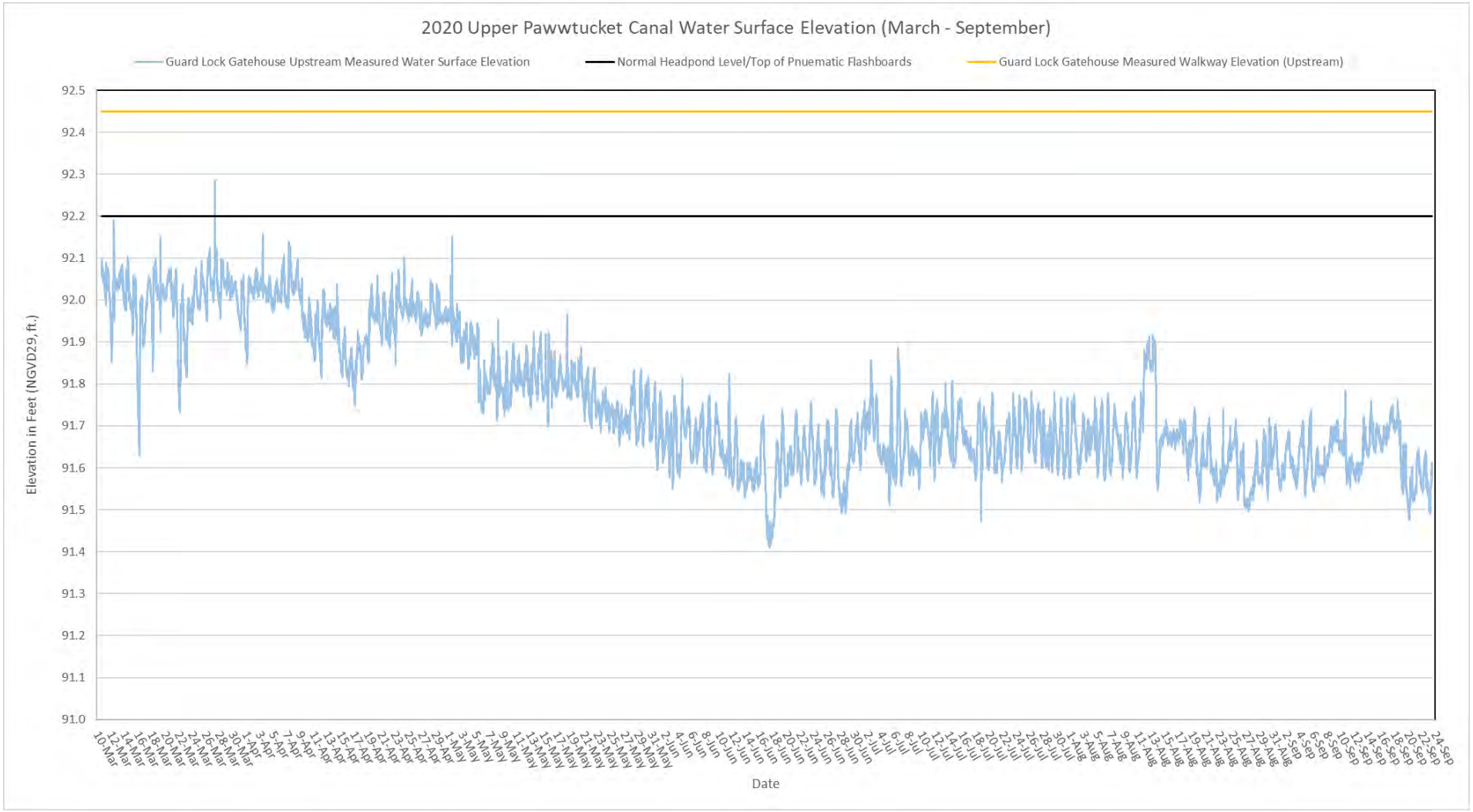
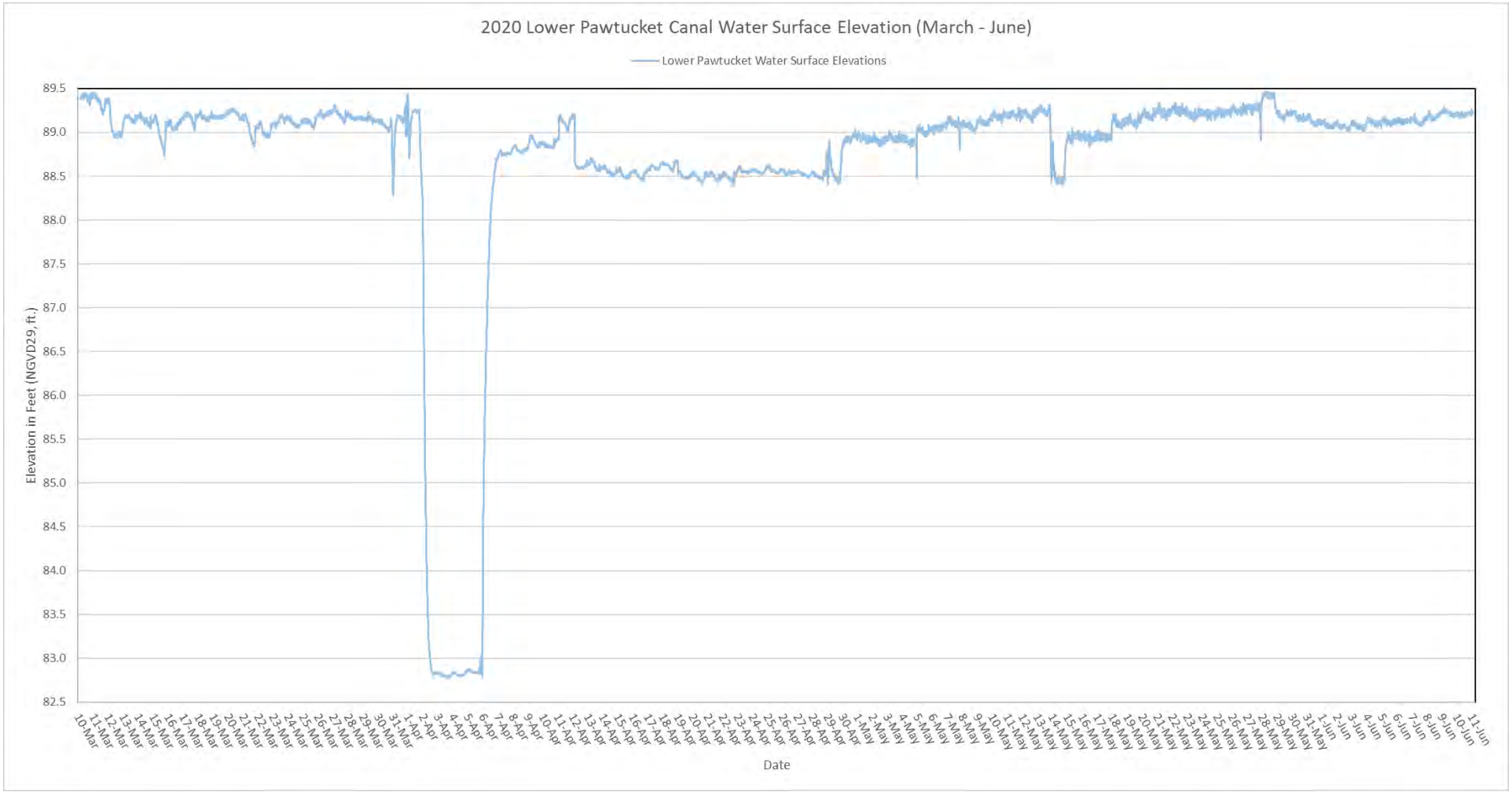


Figure 5-6. 2020 Lower Pawtucket Canal Water Surface Elevation (March 10 – June 11)

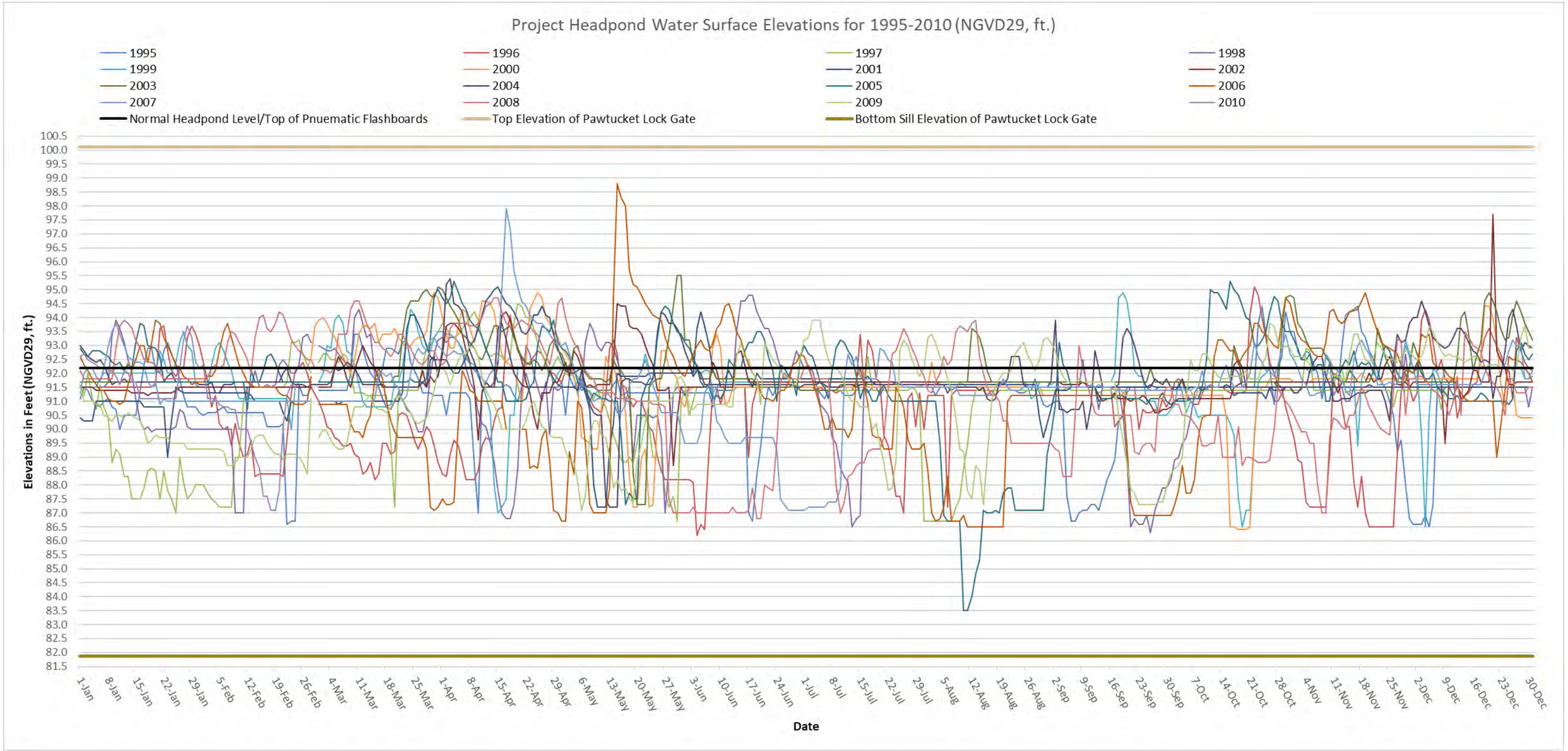


5.3 Project Operations Review

Boott has reviewed the operational data for the Pawtucket Dam headpond elevations and the E.L. Field Powerhouse forebay elevations for the available period of record (January 1995 through December 2010 (Figure 5-7 and Figure 5-8). These data are from the period when 5- foot- high wooden flashboards were deployed on the spillway crest, prior to the construction of the present pneumatic crest gate system. The data demonstrate that with the wooden flashboards, headpond levels were highly variable, due in large part to the Licensee's inability to maintain normal pond level when the flashboards were partially damaged or failed. Repair and replacement of the failed flashboards required a 5-foot drawdown of the project impoundment, typically for 2 days, to enable safe working conditions on the dam crest. In contrast, the pneumatic crest gate system maintains a steady impoundment level by automatically adjusting the height of the crest gate panels in response to increasing flows (Figure 5-1 and Figure 5-2). As flows recede the crest gates are automatically raised, thereby eliminating any need for impoundment drawdowns for flashboard repairs. With the original flashboards in place, headpond elevations were driven by the type of water year (wet, normal, dry) and were much more variable, although typical for a riverine environment. Figure 5-7 shows that during most normal years the headpond is maintained at or near crest elevation for a large portion of the year. Exceptions occur during seasonal spring freshet (mid-March to mid-April), during the fall rainy season (mid-October to early December) and during the occasional anomalous event.

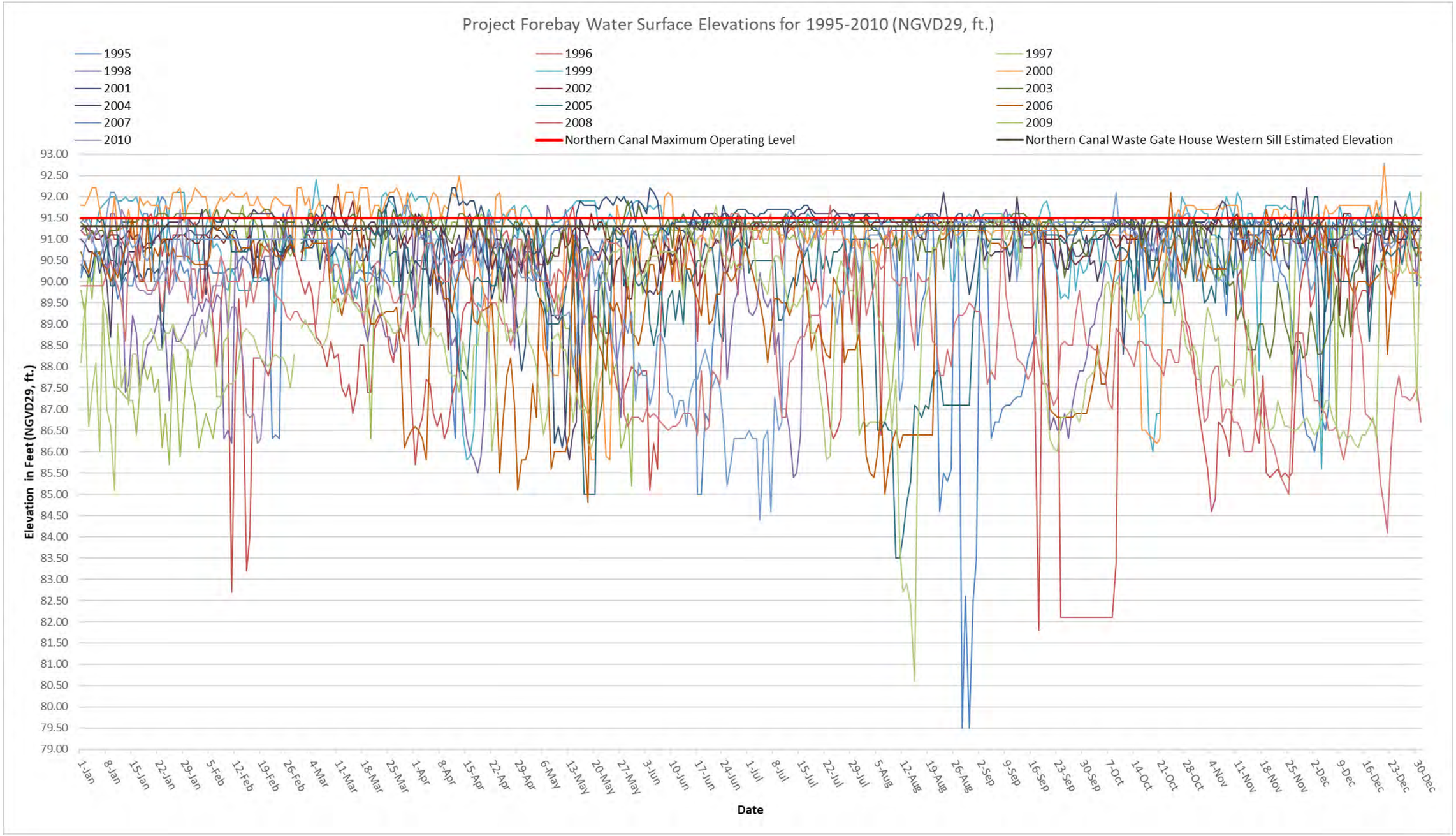
Notable in both the current data set with the crest gate (Figure 5-3 and Figure 5-4) and the historic data set with flashboards (Figure 5-3 and Figure 5-4) is that there is often a large water level differential across the Pawtucket Gatehouse, often reaching 3 or more feet. Normally, this differential would be only 0.7 ft, i.e., 92.2 ft normal pond elevation versus 91.5 ft maximum Northern Canal elevation. However larger differentials may occur, typically due to debris accumulation on the upstream side of the gatehouse, which restricts flow through the headgates (Photo 5-1). Large differentials are most common during the late winter and spring, when increased river flows bring large amounts of river debris down the river. This is a factor which has not been changed by the replacement of the original wooden flashboards with the pneumatic crest gates. Boott has not analyzed the data sufficiently to determine whether there is any difference in differentials between the pre- and post- crest gate data.

Figure 5-7. Merrimack River – Pawtucket Dam Headpond Elevations for Period of Record (1995-2010)[4]



[4] Period of Record Data 1995-2010 was recorded with 5-foot high wooden flash boards in operation and prior to the installation of the automated pneumatic flashboards along the crest of the Pawtucket Dam.

Figure 5-8. Northern Canal E.L. Field Powerhouse Forebay Elevations for Period of Record (1995-2010)



5.4 Structural Engineering Assessment of the Great River Wall

A structural engineering assessment of the Great River Wall is designated as Critical Energy Infrastructure Information and as such is not available for public distribution.

5.5 Analysis of Potential Project Related Effects

Pursuant to the RSP, Boott analyzed the information obtained from sections 5.1 through 5.4 above, to assess the potential for project related effects to cause adverse impacts to the historical structures along the Northern and Upper Pawtucket Canals. Factors that may have the potential to effect historic resources can vary according to several factors including but not limited to Project operations, the magnitude and duration of natural high and low flow events, river debris and trash accumulation, natural decay, Project related maintenance, and non-Project related maintenance by other entities.

5.5.1 Northern Canal Lock and Pawtucket Gatehouse

The Northern Canal Lock and the Pawtucket Gatehouse (Photo 5-1) is located at the southern abutment of the Pawtucket Dam and controls flow into the Northern Canal. It is principally constructed of dressed masonry with concrete over lintels and contains ten 8-foot-wide by 15-foot-high, motor-operated, timber sliding gates which feed the Northern Canal. Another small intake opening feeds a presently unused wheel, which formerly powered the gate mechanisms through a line shaft. The structure's water passages are nearly 80 ft in length. A small navigation lock is located at the southerly end of the Pawtucket Gatehouse (Photo 5-2) (Boott 2017).

The Project is operated in a run of river mode (ROR) where outflow approximates inflow, generally maintaining the Project headpond at or near elevation 92.2 ft (see Figures 5-1 through 5-4). Under normal operations, Boott operates the Project to prioritize the E.L. Field Powerhouse generating units. When flows exceed the 6,600 cfs combined hydraulic capacity of the E.L. Field generating units, it has been Boott’s practice to divert up to 2,000 cfs to the downtown canal units when they are operable. Flows higher than 8,600 cfs (the combined capacity of the E.L. Field Powerhouse and the canal units) are spilled over the Pawtucket Dam spillway and into the Project’s bypass reach. The pneumatic crest gate system has a control system which maintains a constant upstream water level during increasing flows, by automatically lowering the crest gate panels as the spillway flow increases.

The concrete and masonry gatehouse show normal wear from exposure to the natural river conditions and Project water level fluctuation. Based on a review of existing documentation and consultation with the NPS, Boott did not identify potential Project-related effects on the gatehouse.

Photo 5-1. Northern Canal Lock and Pawtucket Gatehouse.

Photo 5-2. Pawtucket Gatehouse at Northern Canal Gate entrance (prior to 2018 gate damage).

Potential Project-related effects have been documented at the Northern Canal lock structure. The lock structure is controlled by a set of timber miter gates, with one set of gates at the upstream entrance/exit and a second set at the downstream entrance/exit. The gates are subject to routine water level fluctuations (see Figure 5-1 through Figure 5-4) that can deteriorate wooden and metal elements. While the magnitude of fluctuation in the Project's headpond has been significantly reduced by the implementation of the pneumatic crest gates, the gates are subject to routine seasonal high flow events. Portions of the gates are also continuously submerged, which contributes to natural deterioration of wooden and metal elements over time. Photo 5-3 shows the normal water level that is maintained approximately midway on the gate height, and Photo 5-4 shows the deterioration of wood and metal on the removed gate normally below the water surface.

On August 26, 2018, the right (facing downstream) timber gate controlling the upstream entrance/exit to the Northern Canal lock was damaged. The damage to the gate was

caused by an unusual back surge of water moving upstream through the Northern Canal, caused by a water level transducer malfunction. Under normal operations, the existing surge gate would be automatically activated upon full shutdown of the E.L. Field units to discharge the resulting back-surge of flow into the bypass reach. In this instance, the surge gate did not open because the malfunctioning transducer at the Pawtucket Gatehouse caused the E.L. Field units to back down rapidly but did not cause the them to trip off-line. As a result, the rapid unit backdown created a water-hammer effect that surged up the Northern Canal and into the miter gates. The gates had been previously chained together at their upper corner (See Photo 5-3), which prevented the gates from opening and releasing the surge as it moved upstream, and thus causing the right gate to break. Boott has recently removed the gate from service and it is currently under repair.

Other factors which have likely contributed to the deterioration of the miter gates include, but are not limited to, high flows in the Merrimack River and natural deterioration of the submerged portions of the wooden gate structure, neither of which are attributable to Project operations.

Photo 5-3. Damage to the Northern Canal Lock Timber Gate.

Photo 5-4. Photo of wear of submerged portion of the Northern Canal Gate removed for repair.

5.5.2 Northern Canal Waste Gatehouse

The Northern Canal Waste Gatehouse is a single-story, heavy-timber-framed building, built circa 1872 atop the Great River Wall which houses gate operators for four canal release gates (Photo 5-5). Based on consultation with the NPS, Boott identified potential Project-related effects on certain wooden structural elements of the Northern Canal Waste Gatehouse. The wooden sills of the gatehouse have experienced deterioration. Boott reviewed Northern Canal water level data recorded in 2020 to determine if Northern Canal water levels could be a contributing factor to the deterioration of the sill.

Photo 5-5. Northern Canal Waste Gatehouse atop the Northern Canal.

As shown in Figure 5-3 and Figure 5-4, the Northern Canal Waste Gatehouse has wooden sill which overhangs the Northern Canal, with a bottom elevation of approximately 91.3 ft NGVD29. The normal maximum operating elevation of the Northern Canal is 91.5 ft. Figure 5-3 and Figure 5-4 show that the canal water surface elevations for the study period occasionally exceeded the bottom sill elevation, thereby inundating the heavy timber bottom sill on the south side of the structure (Photo 5-6). The Northern sill of the Waste Gatehouse has also deteriorated, due to natural exposure to the nearby river and atmospheric conditions, as well as its proximity to the spillway immediately to the east. It is possible that splashing water from the adjacent spillway may have contributed to the deterioration of the eastern third of the northern sill timber. Repeated inundation and drying of the timber sill can be a contributing factor to deterioration. Other factors, including the age of the wooden timbers, general maintenance, weathering, and atmospheric conditions are also likely to have contributed to the deterioration of the southern sill, and the eastern portion of the northern sill. The age of the sills is not known, i.e., it is not known if the existing sills are the original timbers from the 1872 construction of the gatehouse.

Photo 5-6. Northern Canal Waste Gatehouse underlying timber sill.

5.5.3 Guard Lock and Gates Facility

The Upper Pawtucket Canal branches off the Merrimack River a few hundred feet upstream of the Pawtucket Dam and feeds water into the downtown canal system via the Guard Lock and Gates Facility ("Guard Locks"). The facility consists of the following structures: 1) the Guard Gatehouse which houses 5 sluice gates to convey flow to the Lower Pawtucket Canal; 2) a 24 ft wide granite masonry Lock Canal with two pairs of wooden lock gates; 3) the timber and wood framed Lock House located above the upstream lock gate; 4) the Francis Gatehouse (or Great Gatehouse) timber and wood framed structure over the Lock Canal which houses the 25' high x 25' wide Francis (or Great) Gate. The Guard Gatehouse is separated from the Lock Canal and associated Lock House and Francis Gatehouse by an island with walls of granite, ledge, or concrete (Photo 5-7).

In its consultation comments, the NPS identified potential Project-related effects on the Guard Lock and Gates Facility. Specific issues identified by the NPS included damage to the upstream side of the gatehouse (including the upstream wooden walkway), erosion of the steps leading to the gatehouse, and damage to the entry door on the east side of the Gate House. Boott reviewed the available information regarding the condition of the Guard Locks Facility with respect to the potential impacts identified by the NPS.

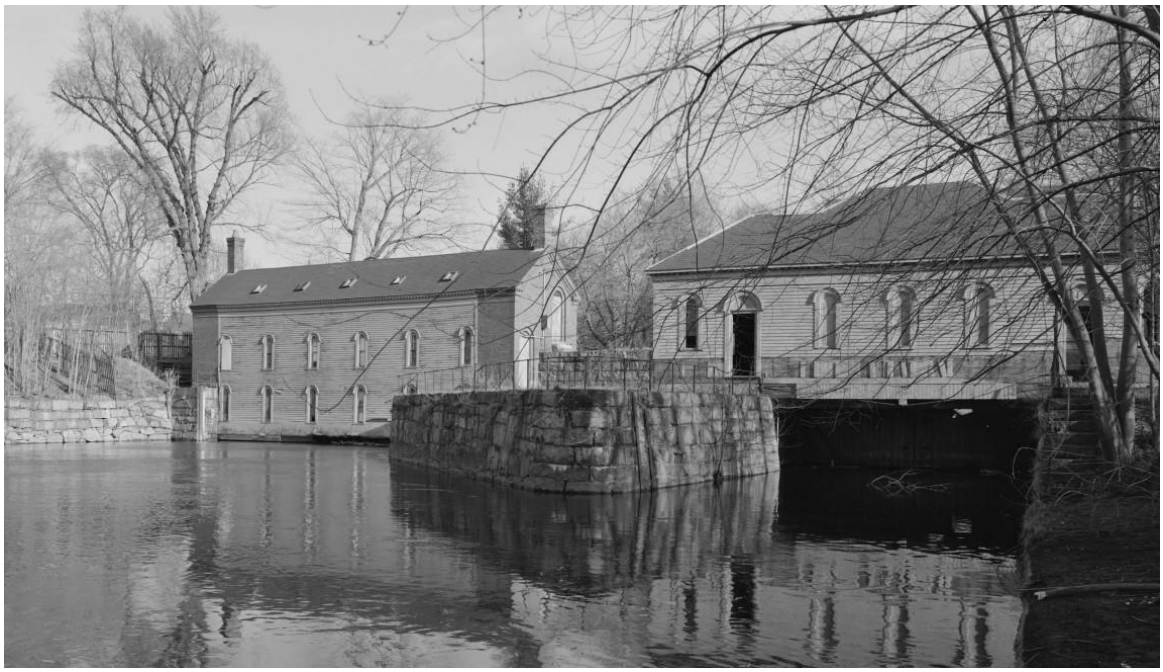


Photo 5-7. 1976 - Guard Lock and Gates Facility viewed from upstream. The Guard Gatehouse is on the left and the Lock Canal and Lock House are on the right.

Photo 5-8. 2019 - Guard Lock and Gate Facility.

Water levels in the Pawtucket Canal upstream of the Guard Locks complex are essentially the same as the project impoundment and remained below the normal headpond level of 92.2 ft NGVD29 throughout the study period except for one occasion. On March 27, 2020 between 11:30 a.m. and 12:00 p.m. the water level in the Pawtucket Canal upstream of the Guard Locks reached 92.29 ft. Figure 5-5 shows the water surface elevation during the study period and the estimated elevation of the Guard Gatehouse walkway (Figure 5-5).

Water levels in the Upper Pawtucket Canal remained below the walkway at the base of the Guard Lock Gatehouse for the entire study (Figure 5-5 and Photo 5-8). The elevation of the walkway (92.45 ft), the clapboard siding (92.45 ft), and the bottom of the mid-level windows (94.08 ft) are all above the normal water level of the Upper Pawtucket Canal (Figure 5-5). Under normal operating conditions, these features are rarely inundated. However, high flow events that are beyond Boott's control can cause water levels to exceed normal operating conditions and may inundate the walkway, clapboard siding, and mid-level windows. As described above, the pneumatic crest gate control system maintains a constant upstream impoundment elevation under elevated flow conditions by automatically adjusting the height of the crest gate panels. The crest gates would be fully lowered at river flows of approximately 35,000 cfs, above which the impoundment and Upper Pawtucket Canal level would rise uncontrolled. Thus, river flows in excess of 35,000 cfs could cause the Upper Pawtucket Canal to inundate the wooden structural elements of the gatehouse; however, these conditions are outside of the ability of the project to control the impoundment water level and therefore not attributable to Project operations.

While normal Project operating conditions do not appear to be having a significant effect on the wooden structural elements of the gatehouse, the presence of waterborne trash and debris may adversely affect the gatehouse. Trash and debris accumulate upstream from Guard Lock Gatehouse, including large logs and timbers. While the magnitude of fluctuation in the Project headpond has been significantly reduced by the implementation of the pneumatic crest gates (see Figure 5-1), the Pawtucket Canal is subject to routine seasonal high flow events, which are more likely to convey trash and debris from upriver areas. While trash and debris that accumulate upstream from the gatehouse have the potential to damage exterior wooden elements and windows under such high flow conditions, natural high flow events and waterborne trash are not related to Project operations. Boott retains a crane service to remove the trash and debris from in front of the Pawtucket Gatehouse once or twice each year.

Boott notes that the top of the steps (104.87 ft) leading to the lower level door of the Guard Gatehouse and the bottom sill of the lower level door itself (100.34 ft) are significantly above the maximum recorded Project headpond elevation for the recent period of record. According to the historic data for the period of record (1995 – 2010) the maximum elevation of the Project headpond was 98.8 ft in 2006. As such, apparent damage to these structural elements are not related to Project operations. The flood of March 20, 1936 was the only event high enough to inundate the gatehouse stairs, reaching a peak elevation of 107.3 ft at a flow of 173,000 cfs.

As is discussed in the Resources, Ownership, Boundaries, and Land Rights Study Report (Study 10), all of the structures within the Guard Lock and Gates Facility are owned by the Proprietors of Locks and Canals and the Commonwealth of Massachusetts, under the administration of the MADCR. In general, the Proprietors own the substructure of each building while the Commonwealth owns the buildings and fixtures above the foundations. Boott generally has easement rights to operate and maintain the water control equipment within each structure. NPS also retains rights to access and implement improvements such as walkway surfaces, lighting, railings, decking, benches, and landscaping. As owners, Proprietors and the Commonwealth have a right and a duty to maintain properties under their ownership, but they do not have an obligation to enhance or upgrade their properties. Similarly, an easement, such as that issued to Boott and/or NPS, allows the holder to conduct routine maintenance of the property under easement.

6 Conclusions

Wooden structural elements of the historic resources located along the Upper Pawtucket and Northern Canals appear most susceptible to damage from submergence, periodic inundation, and waterborne trash.

While the magnitude of fluctuation in the Project's headpond and the Pawtucket Canal has been significantly reduced by the implementation of the pneumatic crest gates, the Merrimack River is subject to routine seasonal high flow events that are beyond Boott's control.

High flow events can also mobilize waterborne trash and debris that have the potential to damage wooden structural elements; however, neither high flow events nor the presence of waterborne trash and debris in the Merrimack River are attributable to Project operations.

The operation of the Northern Canal has caused periodic inundation of the sill at the Northern Canal Waste Gatehouse. This inundation may be one factor in the continued deterioration of the gatehouse's southern sill. Spray from the canal spillway may also be contributing to deterioration along the eastern end of the northern sill.

While normal Project operations do not appear to be adversely affecting the Pawtucket Gatehouse Lock Structure beyond normal wear, at least one incident appears to have contributed to recorded damage to the upstream miter gate. The canal surge event that occurred in 2018 was caused by the malfunction of a water level transducer. The effect of the resulting surge was exacerbated by the practice of chaining the gates closed. This anomalous incident does not represent normal Project operations, and Boott is repairing the damage to the gate.

7 Variances from FERC-Approved Study Plan

The Water Level and Flow Effects on Historic Resources Study Report was conducted in full accordance with the methods described in the FERC-approved study plan except for the following variances:

- During meetings and consultation with the NPS after the issuance of the SPD, the stakeholders agreed to reduce the focus of this study limiting it to the Upper Pawtucket Canal from the Merrimack River downstream to the Guard Locks, and including a portion of the Project headpond in proximity to the Pawtucket Dam and the Northern Canal from the Pawtucket Dam to the E.L. Field Powerhouse.
- Because of the current COVID-19 pandemic, neither multiple-party site visits nor public meetings were conducted as part of this study. Boott consulted with the NPS to identify previous damage to historic resources within the study area and to collect additional information on the nature and extent of the damage.

8 Germane Consultation and Correspondence

A summary of germane correspondence and consultation related to the Water Level and Flow Effects on Historic Resources Study Report is presented in Table 8-1. Appendix C provides copies of relevant correspondence.

Table 8-1. Germane Consultation and Correspondence

Date	Type	From	To	Subject
May 5, 2019	Letter	Boott	NPS	Consultation on locations for level logger deployment
January 4, 2021	Letter	Boot	NPS	Request for Information for Water Level and Flow Effects on Historic Resources Study
February 3, 2021	Letter	NPS	Boott	Response to Requested Information

9 Literature Cited

Hay. (1991). A History of Hydroelectric Power in New York State. Albany, NY: New York State Museum.

Massachusetts Department of Conservation and Recreation (MADCR). 2014. Lowell/Greater Brook Planning Unit.

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National Park Service. (NPS). 1981. Final General management Plan https://www.nps.gov/Lowell/learn/management/upload/1981-LOWE-GMP.pdf [Accessed August 1, 2020].

Appendix A - Documents Reviewed

Appendix B - Structural Engineering Assessment of the Great River Wall (Critical Energy Infrastructure Information)

Appendix C - Germaine Consultation and Correspondence

Three-Dimensional Computational Fluid Dynamics Modeling Study Report

Lowell Hydroelectric Project

(FERC No. 2790)

February 25, 2021

Prepared by:

HDR

Prepared for:

Boott Hydropower, LLC
Manchester, New Hampshire

Central Rivers Power

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Contents

Tables

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List of Acronyms

3-D	three dimensional
Boott	Boott Hydropower, LLC (or Licensee)
CFD	Computational Fluid Dynamics
C.F.R.	Code of Federal Regulations
DEM	digital elevation model
FERC	Federal Energy Regulatory Commission (or Commission)
GIS	Geographic Information System
ILP	Integrated Licensing Process
ISR	Initial Study Report
LES	Large Eddy Simulation
LiDAR	Light Detection and Ranging
MW	megawatt
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Vertical Datum 1929
NOI	Notice of Intent
PAD	Pre-Application Document
Project	Lowell Hydroelectric Project (or Lowell Project)
PSP	Proposed Study Plan
RM	river mile
RNG	Renormalized Group
ROR	run-of-river
RSP	Revised Study Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SPD	Study Plan Determination
STL	Standard Tessellation Language

TIN	triangulated irregular network
URANS	Unsteady Reynolds Averaged-Navier Stokes
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOF	Volume of Fluid
WSE	water surface elevation

1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20.2-megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

In accordance with 18 C.F.R. § 5.15, Boott has conducted studies as provided in the study plan and schedule approved in the Commission's March 13, 2019 Study Plan Determination (SPD) for the Project. This report describes the methods and results of the approved Three-Dimensional Computational Fluid Dynamics Modeling Study conducted as part of obtaining a new license for the Project.

Boott notes that the results presented in this report are preliminary and incomplete. Due to diverse locations and accessibility of the areas surveyed in the canal, forebay, tailrace, bypass reach and within the fish lift and fish ladder structures, bathymetric and flow data collection surveys were needed, and separate computational fluid dynamics (CFD) models need to be constructed. The calibrated and validated CFD models will run simulations under various input operational scenarios. Boott proposed a suite of potential simulation runs based on input provided by National Marine Fisheries Service in the RSP, but information from the now-complete telemetry studies (Downstream American Eel Passage Study, Juvenile Alosine Downstream Passage Assessment Study, and the Upstream and Downstream Adult Alosine Passage Assessment) may be used to better inform the selected simulated conditions of the CFD models.

Boott anticipates providing additional results of CFD model development by March 30, 2021 after CFD models for the fish ladder, E.L. Field Powerhouse, and the tailrace have been further refined. Boott anticipates conducting a working group meeting with stakeholders to discuss their preferred scenarios to be simulated.

1.1 Project Description and Background

The Lowell Project is located at river mile (RM) 41 on the Merrimack River in the City of Lowell in Middlesex County, Massachusetts, with an impoundment extending approximately 23 miles upstream into Hillsborough County, New Hampshire. The existing Lowell Project consists of:

1) A 1,093-foot-long, 15-foot-high masonry gravity dam (Pawtucket Dam) that includes a 982.5-foot-long spillway with a crest elevation of 87.2 feet National Geodetic Vertical Datum 1929 (NGVD 29) topped by 5-foot-high pneumatically-operated crest gates deployed in five independently-operable zones;

2) A 720-acre impoundment with a normal maximum water surface elevation of 92.2 feet NGVD 29;
3) A 5.5-mile-long canal system which includes several small dams and gatehouses;
4) A powerhouse (E.L. Field) which uses water from the Northern Canal and contains two turbine-generator units with a total installed capacity of 15.0 megawatts (MW);
5) A 440-foot-long tailrace channel;
6) Four powerhouses (Assets, Bridge Street, Hamilton, and John Street) housed in nineteenth century mill buildings along the Northern and Pawtucket Canal systems containing 15 turbine-generator units with a total installed capacity of approximately 5.1 MW;
7) A 4.5-mile-long, 13.8-kilovolt transmission line connecting the powerhouses to the regional distribution grid;
8) Upstream and downstream fish passage facilities including a fish elevator and downstream fish bypass at the E.L. Field powerhouse, and a vertical-slot fish ladder at the Pawtucket Dam; and
9) Appurtenant facilities.

At the normal pond elevation of 92.2 feet NGVD 29 (crest of the pneumatic flashboards), the surface area of the impoundment encompasses an area of approximately 720 acres. The gross storage capacity between the normal surface elevation of 92.2 feet and the minimum pond level of 87.2 feet is approximately 3,600 acre-feet. The Project operates in a run-of-river (ROR) mode using automatic pond level control and has no usable storage capacity.

The Project is located along the Merrimack River in Middlesex County, Massachusetts and in Hillsborough County, New Hampshire. On April 30, 2018, Boott initiated the ILP by filing a Pre-Application Document (PAD) and Notice of Intent (NOI) with the Commission. Major ILP milestones to-date are presented in Table 1-1.

Table 1-1. Major ILP Milestones Completed

Date	Milestone
April 30, 2018	PAD and NOI Filed
June 15, 2018	Scoping Document 1 (SD1) Issued by FERC
July 17, 2018	FERC Agency and Public Scoping Meetings Conducted
July 18, 2018	Project Site Visit Held
September 27, 2018	Scoping Document 2 (SD2) Issued by FERC
September 28, 2018	Proposed Study Plan (PSP) Filed

Date	Milestone
October 18 & 19, 2018	PSP Meeting Conducted
January 28, 2019	Revised Study Plan (RSP) Filed
March 13, 2019	FERC Issued Study Plan Determination (SPD)
February 25, 2020	Initial Study Report (ISR) Filed
March 11, 2020	ISR Meeting
June 12, 2020	FERC Issued Revised Process Plan and Schedule
September 30, 2020	Revised ISR Filing
December 2, 2021	Draft License Application filed
February 2, 2021	FERC Issued Determination on Study Modification Requests

Boott has continued consultation with stakeholders regarding the approved studies as required by the Commission's SPD. In accordance with the schedule presented in the RSP, Boott has also provided stakeholders with Quarterly ILP Study Progress Reports that include a description of study activities conducted during the previous quarter, activities expected to occur in the next quarter, and identified variances from the approved study plan.

2 Study Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the Lowell Project's fish passage facilities (including around the fishway entrances, within fishway structures, and in the E.L. Field Powerhouse forebay) may influence fish behavior in response to hydraulics. Information from the now-complete telemetry studies (American Eel Passage Downstream Study, Juvenile Alosine Downstream Study, and Adult Alosine Passage Study Upstream and Downstream) may be used to inform the simulated conditions of the CFD models. This is anticipated to aid in the interpretation of preferable conditions for the guidance of migrating fish to and through the fish passage facilities. The objectives of this study are to:

- Develop and calibrate three-dimensional models of areas pertinent to fish passage structures;
- Simulate various operational conditions using each model; and
- Produce a series of color contour maps depicting flow fields relating to fishway attraction, fishway hydraulics, and forebay and bypass approach.

3 Study Area

The study area includes the E.L. Field Powerhouse forebay, tailrace, and fish lift, the bypass reach in the vicinity of the Pawtucket Dam fish ladder entrance, and within the fish ladder.

4 Model Development

4.1 Model Description

FLOW-3D is a commercially available solver capable of solving the three-dimensional (3-D) Unsteady Reynolds Averaged-Navier Stokes (URANS) equations. The software utilizes a Volume of Fluid (VOF) method to calculate the free surface within the domain (Hirt & Nichols, 1981). The package contains the meshing module (pre-processor), solver, and post-processor. FlowSight was used to produce the results presented below and was provided with the FLOW-3D software package.

4.1.1 Modeling Approach

FLOW-3D is software developed and supported by Flow Science, Inc. The governing equations used in Flow-3D can be found in the user's guide (Flow Science, Inc, 2019). The software solves fully URANS equations on structured grids. A model fitted mesh was developed for the proposed auxiliary spillway modification. A known water surface elevation (WSE) was applied to the upstream boundary of the CFD model. Applying the known WSE reduces the complexity of the URANS equations.

4.1.1.1 Pressure Solver Options

Two numerical schemes are available for the pressure solver with multiple options. Explicit and implicit solvers are available. Within the Implicit solver, multiple options are available. Limited compressibility models can be toggled to relax the constraints of the pressure solver for cases where solution stability is an issue. The implicit pressure solver was applied to the model for the results presented below.

4.1.1.2 Turbulence Models

Various one (Prandtl Mixing Length and Turbulent Energy Model) and two equation (k-ε, k-ω, and RNG) turbulence models are available in FLOW-3D. A Large Eddy Simulation (LES) model is also available for selection depending on the type of flow expected and desired flow feature resolution. The Renormalized Group (RNG) model was selected and is an applicable closure for the CFD study based on anticipated flow patterns (Orszag & Yakhot, 1986).

4.1.1.3 Model Limitations

The CFD model is limited in the data it can accurately produce. Some hydrodynamic features are not accurately modeled with the selected solver and turbulence closure. Recirculation patterns and vortices are approximate in size and strength.

4.2 Model Geometry

HDR developed a topographic digital elevation model (DEM) using Geographical Information Systems (GIS). All geo-processing of the following data sources was achieved using the ArcMap (Esri) application's 3D Analyst geo-processing tools.

A single DEM was created from the following data sources:

- Ortho imagery Light Detection and Ranging (LiDAR) based elevation data collected by the Normandeau Associates provided in coordinate system UTM Zone 19N, NAD 83 2011, units meters, North American Vertical Datum of 1988 (NAVD 88), units meters.
- Bathymetry depth points collected by Normandeau Associates. These areas were site specific to three areas 1) just upstream of the main dam fish ladder, 2) power canal, and 3) powerhouse tail race. Data provided in coordinate system UTM Zone 19N, NAD 83 2011, units meters, vertical datum NAVD 88, units feet.
- LiDAR acquired from United States Geological Survey (USGS) LAS format 2011. Data provided in coordinate system Universal Transverse Mercator (UTM) Zone 19N, NAD 83, units meters, vertical datum NAVD 88, units meters.

Most of the coverage area required for CFD modeling was comprised of data received by Normandeau Associates as a randomly spaced point cloud xyz file. The xyz file was derived from remotely sensed survey in NAVD 88 vertical datum. These data were transformed as a discrete point feature class using "ASCII 3D to Feature Class" geo-processing tool. Both the horizontal coordinate system (UTM 83 meters) and vertical units (NAVD 88 meters) were maintained.

The vertical units for the bathymetric survey data points were converted from feet to meters in order to match the vertical units of the larger areas of the overall CFD model area.

In several small overbank areas upstream of the fish ladder and east bank of the power canal and tailrace, additional terrain data was needed to provide additional detail. USGS LiDAR randomly spaced point cloud data was utilized. These USGS LiDAR derived files were converted from LAS to points using geo-processing tools "LAS Dataset to TIN" then "TIN Node".

In the areas of the fish ladder and fish elevator, polygon feature class were created to depict an area of flat elevation slightly higher in elevation than the bottom of Standard

Tessellation Language (STL) in order to exclude water from seeping between the final terrain DEM and the STL.

All components as described above were combined into a triangulated irregular network (TIN) using the "Create TIN" geo-processing tool. This resulting TIN was then converted to a final DEM raster using "TIN to Raster" (1 X 1-foot postings raster resolution, "Project Raster" (convert from UTM to State Plane coordinates), and "Raster Calculator" (convert vertical units from meters to feet". A final step to convert the .tiff raster to ASCII file "Raster to ASCII" for final import into the CFD model.

The fish ladder and E.L. Field Powerhouse structures were created in AutoCAD and exported to an STL. The STLs and ground surface were rotated to align to an arbitrary vertical position. The rotation allows the structure location to align with the orthogonal mesh elements required for the solver. The rotated model reduces the number of mesh elements necessary to define the features within the model domain.

5 Mesh Development

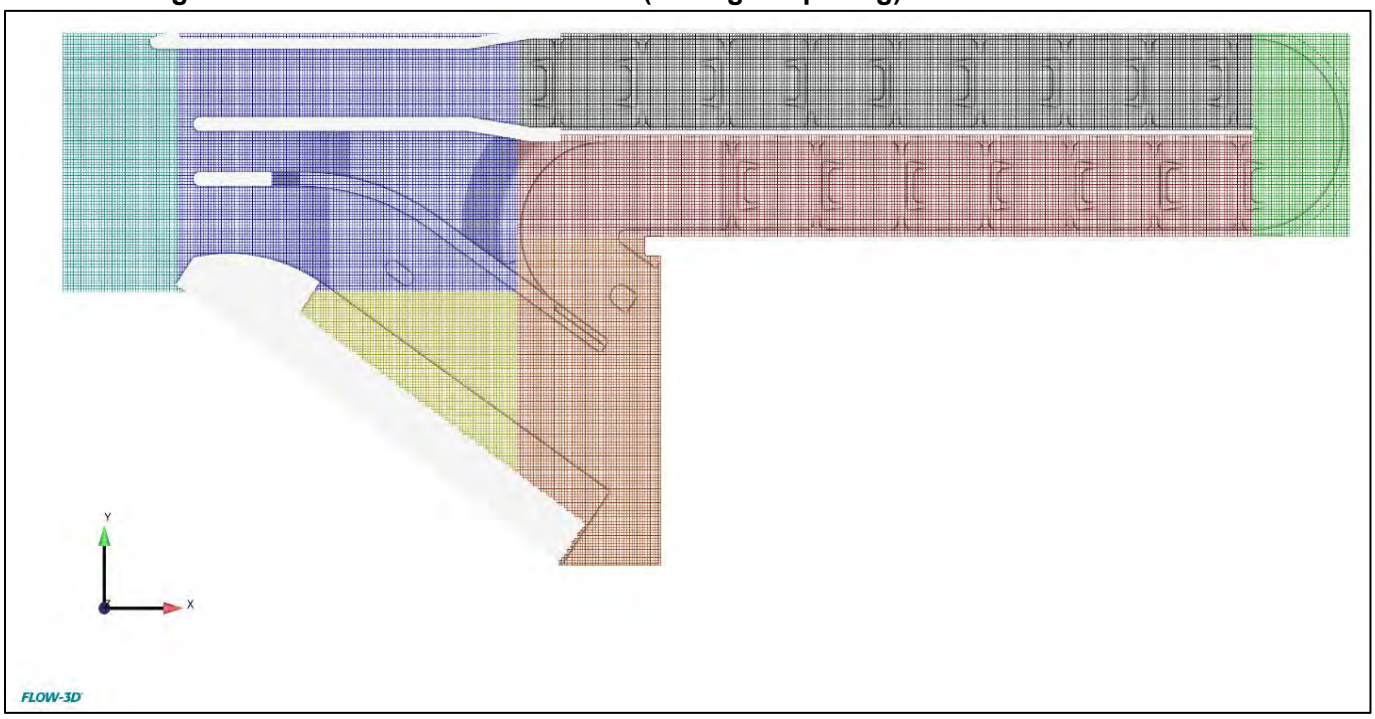
The pre-processor for FLOW-3D works with orthogonal elements. The model topography and features were rotated to capture significant features with fewer elements. A balance between mesh density and computational time was desired. Several iterations of mesh density were performed, providing the basis for a mesh sensitivity analysis. A multi-block approach was utilized to build the model domain. The use of a multi-block domain allows multiple mesh sizes to be used throughout the domain. Each mesh block conformed to best practice guidelines provided by FlowScience (Flow Science, Inc, 2019).

5.1 Fish Ladder

5.1.1 Mesh Sensitivity Study

Multiple meshes of the fish ladder were analyzed to determine if the solution was grid independent. The first grid tested used 0.8-ft spacing in all three axial directions (coarse). After completion of the first simulation, the grid was refined to use a 0.4-ft spacing in all three axial directions (standard). The 0.4-ft mesh was further refined in a third test to limit the mesh spacing to 0.2-ft (refined). Figure 5-1 shows the meshed blocks with 0.4-ft spacing.

Figure 5-1: Fish Ladder Mesh Blocks (0.4-ft grid spacing)



5.1.2 Model Development Scenario

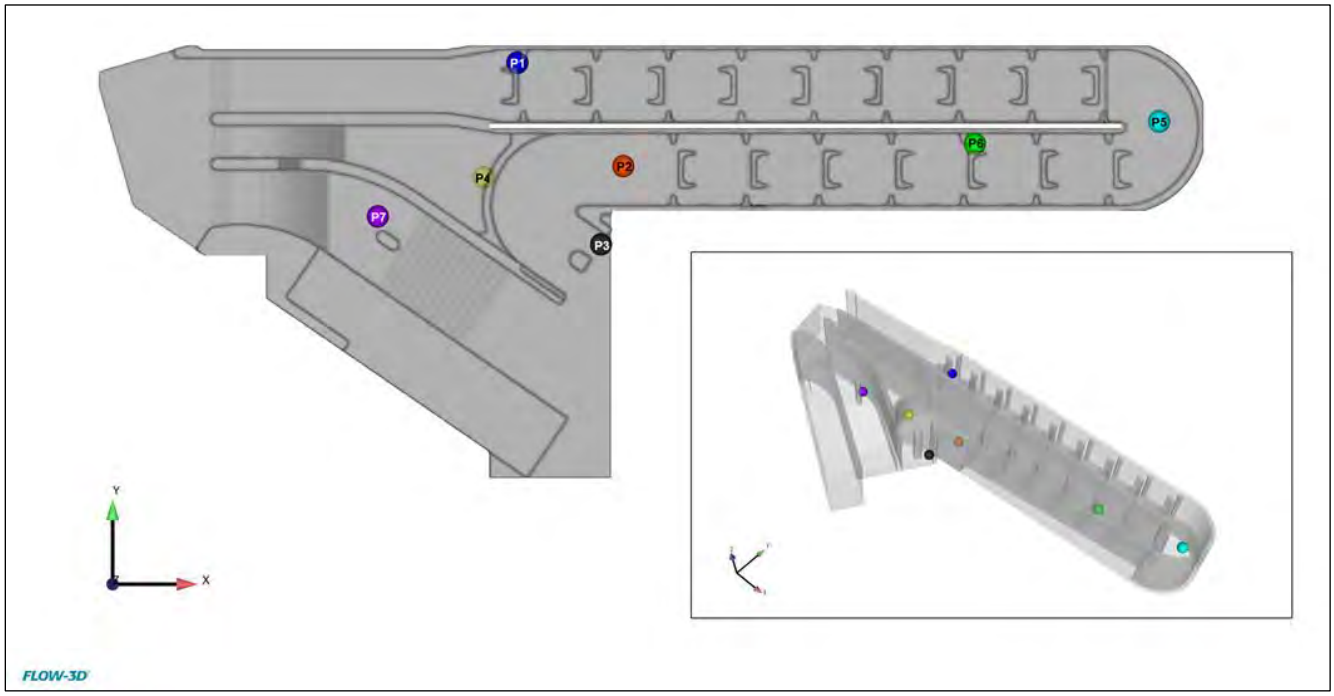
During the mesh development stage of the CFD study, multiple runs using identical boundary conditions were completed to determine the sensitivity to mesh parameters. Virtual probes measuring depth and velocity were placed throughout the fish ladder to measure the effects of the mesh refinement on model hydraulics. Table 5-1 lists the probes and corresponding hydraulic measurements. Figure 5-2 shows the virtual probe locations.

Table 5-1: Virtual Probe Measurements

Probe	Mesh Refinement	Depth		Velocity		Depth-Average Velocity	
		ft	*vs std*	*fps*	*vs std*	*fps*	*vs std*
P1	Coarse	6.15	2.50	6.57	1.42	3.40	-1.60
	Standard	3.65		5.15		5.00	
	Refined	3.66	0.00	5.56	0.42	5.31	0.31
P2	Coarse	3.98	-4.02	2.64	0.84	7.86	4.79
	Standard	7.99		1.80		3.06	
	Refined	8.23	0.23	0.75	-1.05	1.56	-1.51
P3	Coarse	9.77	7.78	9.83	0.50	1.99	-7.26
	Standard	1.99		9.33		9.25	
	Refined	1.80	-0.19	9.77	0.43	9.56	0.31
P4	Coarse	3.16	-4.16	5.11	-0.47	7.59	4.49

Probe	Mesh Refinement	Depth		Velocity		Depth-Average Velocity	
		ft	*vs std*	*fps*	*vs std*	*fps*	*vs std*
	Standard	7.32		5.58		3.10	
	Refined	8.06	0.74	4.07	-1.51	3.97	0.87
P5	Coarse	3.25	-0.79	3.17	1.26	3.81	1.83
	Standard	4.03		1.90		1.98	
	Refined	4.09	0.06	2.07	0.17	2.18	0.20
P6	Coarse	4.77	0.97	5.04	1.75	3.73	0.48
	Standard	3.80		3.29		3.25	
	Refined	3.95	0.15	3.48	0.19	3.37	0.12
P7	Coarse	22.76	22.05	22.14	21.92	0.90	-21.53
	Standard	0.71		0.22		22.43	
	Refined	0.78	0.07	15.08	14.86	22.38	-0.05

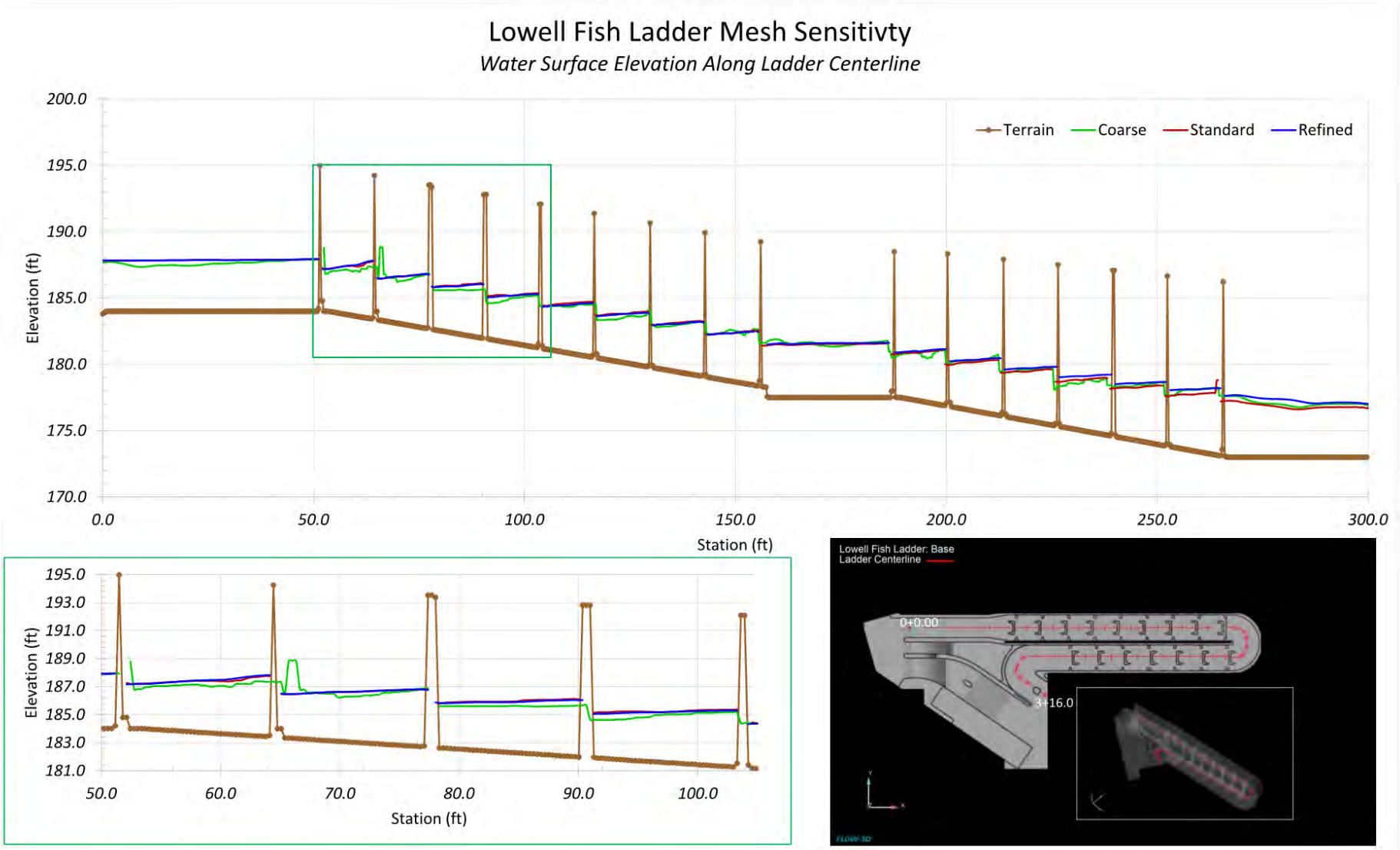
Figure 5-2: Mesh Sensitivity Probe Locations



Water surface elevations were measured along the centerline of the fish ladder and compared between the three mesh refinement levels. This comparison is shown in Figure 5-3.

The standard 0.4' grid spacing was selected for the final model. Water surface elevations differences were negligible, and depth and velocity differences were minor between the refined and standard grid spacing.

Figure 5-3: Water Surface Elevation Comparison



5.1.3 Adding Terrain

Following the mesh sensitivity study, the Merrimack River bathymetry and Pawtucket Dam were added upstream and downstream of the fish ladder. The combined bathymetry, dam, and fish ladder geometry is shown in Figure 5-4. It should be noted that the best available LiDAR data was used to capture the downstream bathymetry. Water levels in the Merrimack River at the time of LiDAR collection were such that only the five most up-stream weirs were captured in the terrain data.

The model extends approximately 300’ upstream of the fish ladder exit and roughly 1000’ downstream to the Mammoth Road Bridge.

As the fish ladder was the area of interest, the combined model mesh was refined to 0.4-ft grid spacing in all three axial directions in the fish ladder vicinity. To facilitate reasonable computation run times, the mesh refinement was decreased from 0.4-ft, to 0.8-ft, and finally 1.6-ft grid spacing moving away from the ladder. The three refinement levels are shown in Figure 5-5 as red (0.4-ft), green (0.8-ft) and blue (1.6-ft grid spacing) areas.

Figure 5-4: Combined Fish Ladder, Dam, and Bathymetry Geometry

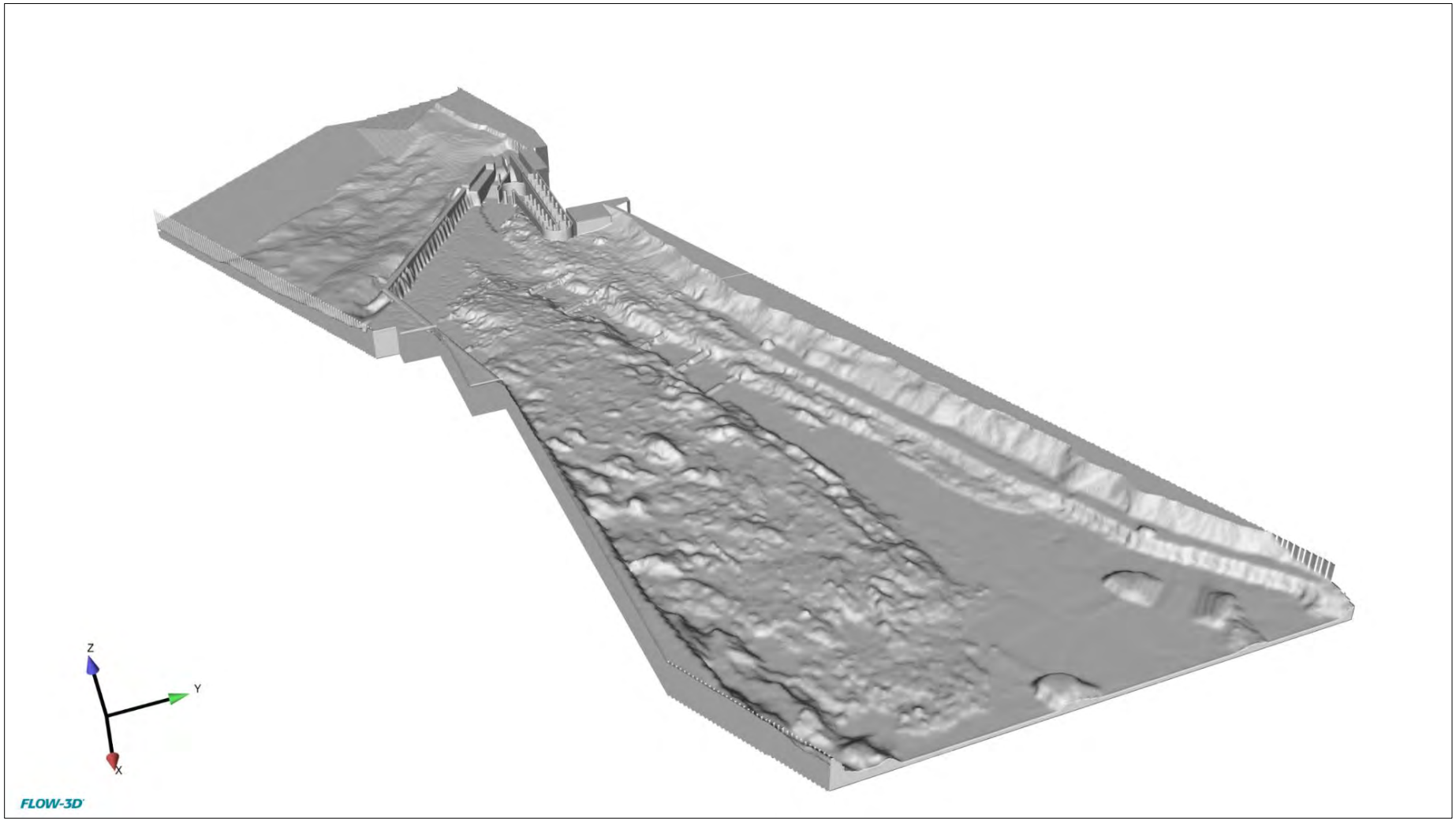
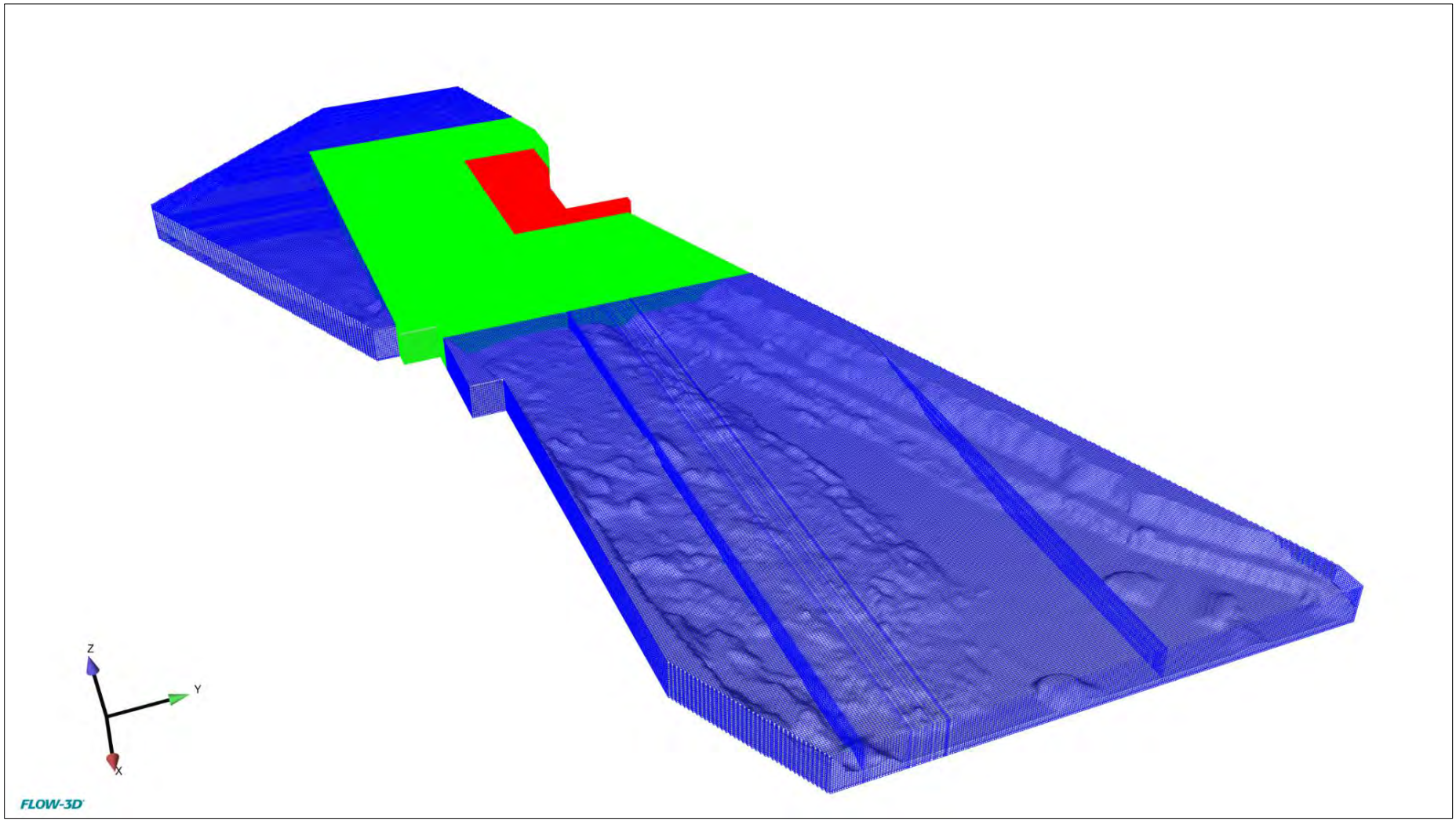


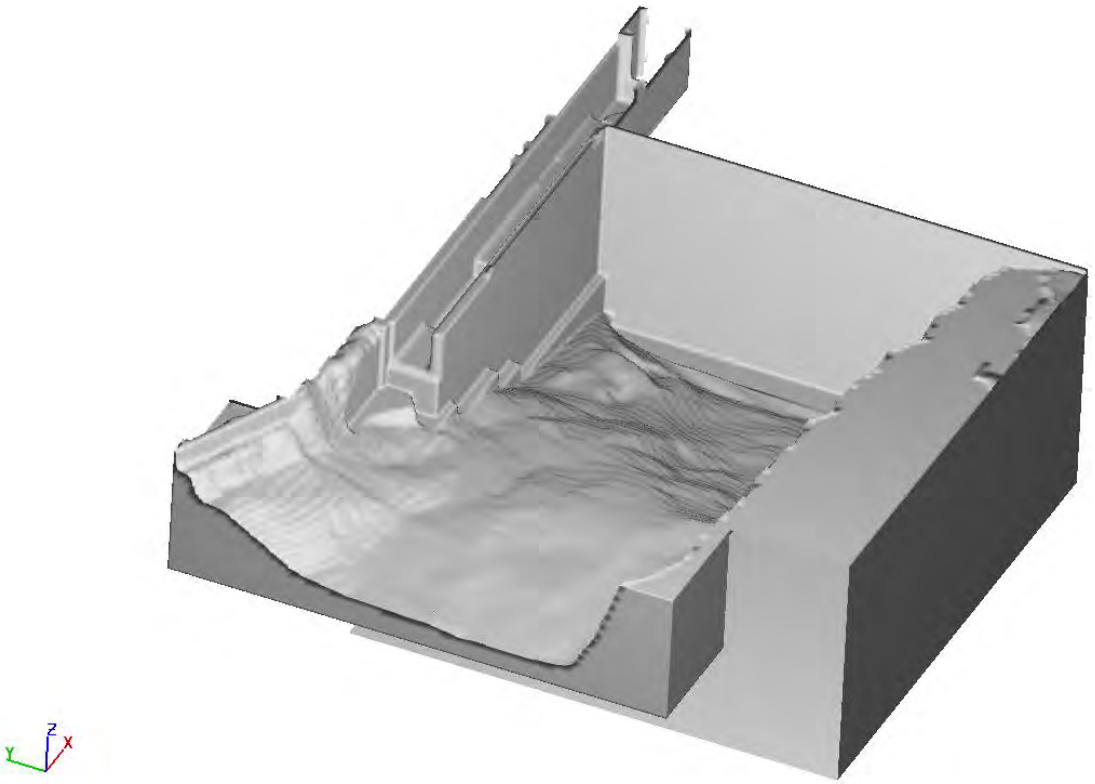
Figure 5-5: Combined Fish Ladder, Dam, and Bathymetry Mesh Refinement Zones



5.2 E.L. Field Powerhouse Model

A model was developed to study the hydraulics of the flow entering the powerhouse forebay. The full model geometry is shown in Figure 5-6.

Figure 5-6: Forebay Model Geometry



5.3 Tailrace Model

A tailrace model was developed to study the hydraulics of the flow leaving the powerhouse. The full model geometry is shown in Figure 5-7. A detailed view of the E.L. Field exits and flow directions with approximate powerhouse inflow boundaries is shown in Figure 5-8.

Figure 5-7:Tailrace Model Geometry

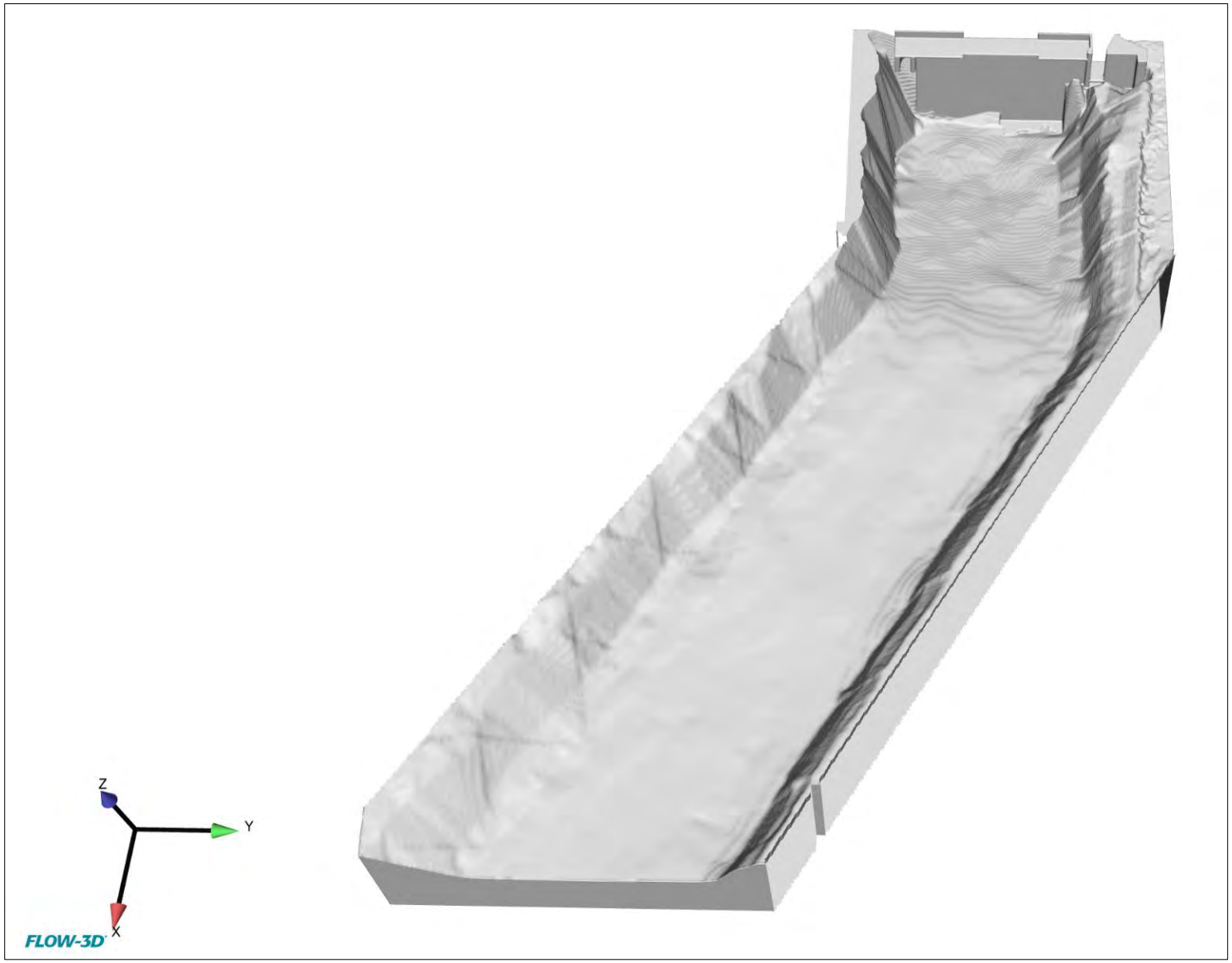
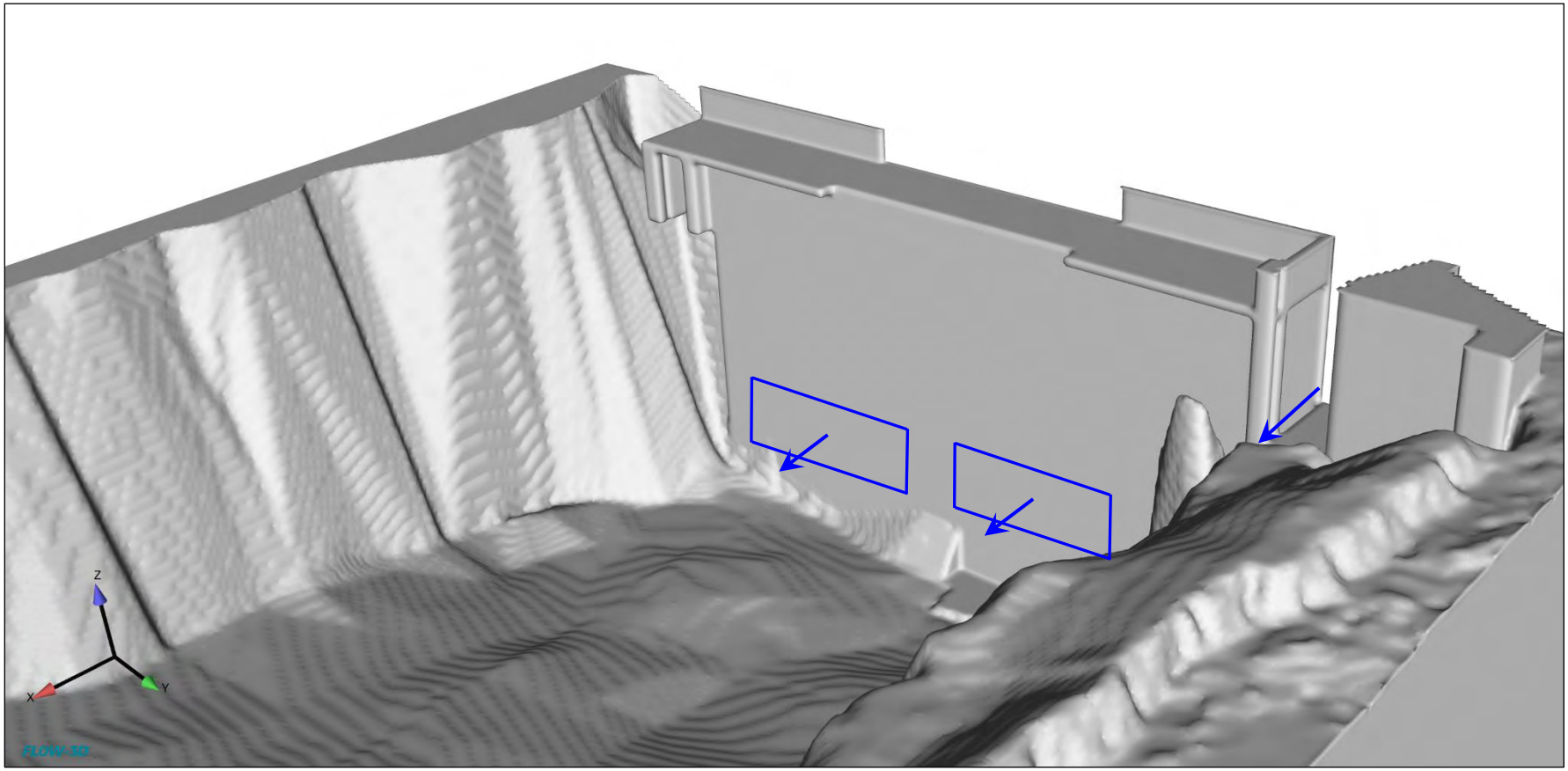


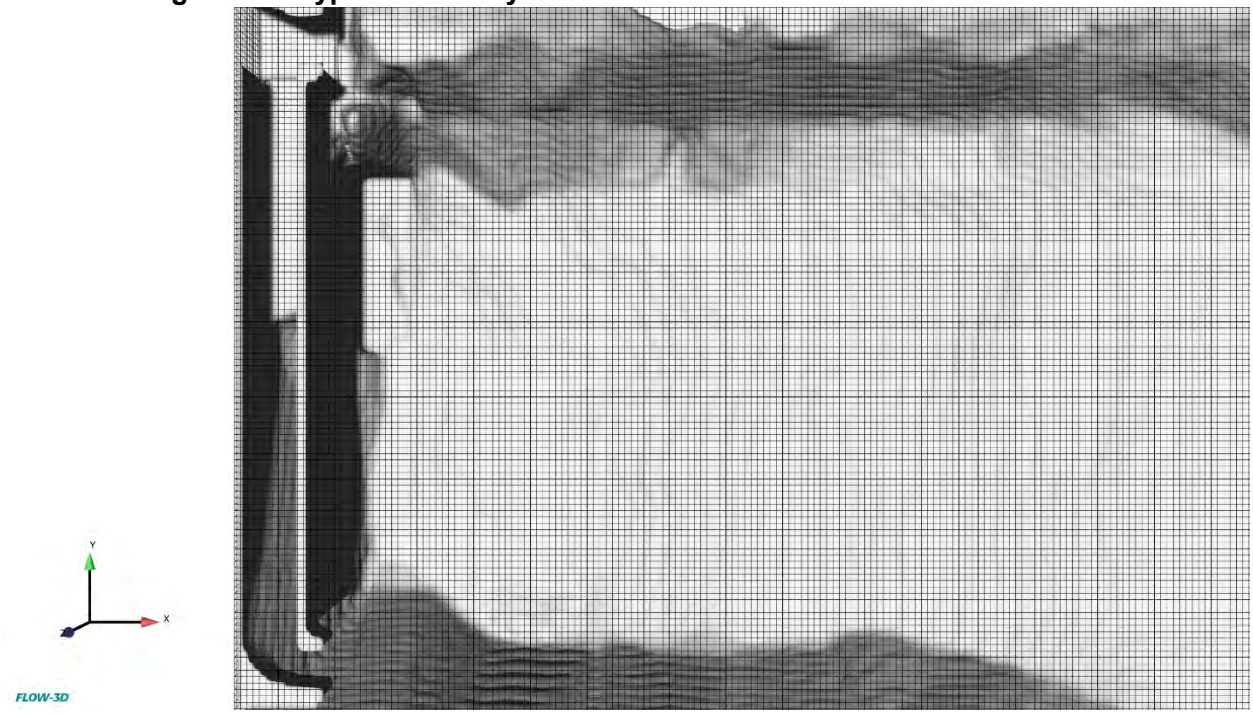
Figure 5-8:Tailrace Model Geometry, E.L. Field Exits and Powerhouse Inflow Boundaries



5.3.1 Mesh Sensitivity Study

Multiple meshes were analyzed to determine if the solution was grid independent. The first grid tested used 1.6-ft spacing in all three axial directions. After completion of the first simulation, the grid was refined to use a 0.8-ft spacing in all three axial directions. To ensure reasonable computation run times, the model mesh was then refined in the first 100' downstream of the powerhouse to 0.4-ft spacing in all three axial directions. The remainder of the domain was left at 0.8-ft spacing. Figure 5-9 shows the mesh for the 0.8-ft spacing in the vicinity of the powerhouse.

Figure 5-9: Typical mesh layout for tailrace model



5.4 Model Approach and Scenarios

Boundary conditions for the CFD model were applied through multiple boundary types. Boundary types for the CFD model are listed below:

5.4.1 Volume flow inlet

The volume flow inlet allows a specified volume of flow to enter the model and was used at the upstream boundary of the model. A directional vector was applied to the inflow. The water surface was known and was specified for the inflow boundary condition.

5.4.2 Pressure Outlet

The pressure outlet specifies a known pressure and/or water surface elevation for the downstream boundary condition. The pressure was specified as atmospheric for the cases below.

5.4.3 Wall

The boundary type wall applied the no-slip condition at the outer boundary of the mesh blocks as well as a zero-velocity condition normal to the boundary.

5.5 Model Evaluation

Completed model runs were evaluated quantitatively and qualitatively using velocity magnitude and flow streamlines. Results are presented below in Section 6. The CFD model solves the URANS equations and data presented at a single time step may contain a maximum or minimum value, which may or may not correspond to the anticipated hydraulic characteristics.

FLUX SURFACES

Flux surfaces were used to monitor the volumetric flow through the spillway and the reservoir.

MONITORING POINTS

Monitoring points were placed within the model to gather point data for the reservoir and area upstream of the spillway. The monitoring points were selected based on their proximity to key model elements.

6 Study Results

As noted above in Section 1, Boott notes that the results presented in this report are preliminary. The calibrated and validated models will run simulations under various input operational scenarios. Boott has refined the suite of potential simulation runs based on input provided by National Marine Fisheries Service in response to the PSP. Boott anticipates providing additional results of the models by March 30, 2021 after models have been further refined. Boott also anticipates conducting a working group meeting to discuss refinement of the models and scenarios to be simulated.

Example preliminary CFD results of the fish ladder, E.L Field Powerhouse, and tailrace model are presented in Appendix A, Appendix B, and Appendix C, respectively.

7 Variances from FERC-Approved Study Plan

As previously noted, due to diverse locations and accessibility of the areas surveyed in the canal, forebay, tailrace, bypass reach and within the fish lift and fish ladder structures, bathymetric and flow data collection surveys were needed, and separate CFD models need to be constructed. Much of the coverage area required for CFD modeling was comprised of data received from Normandeau Associates while conducting the now-complete telemetry studies (Downstream American Eel Passage Study, Juvenile Alosine Downstream Passage Assessment Study, and Upstream and Downstream Adult Alosine Passage Assessment). Consequently, Boott is still working on development and refinement of the CFD models.

Boott anticipates providing additional results of CFD model development by March 30, 2021 after CFD models for the fish ladder, E.L. Field Powerhouse, and the tailrace have been further refined. Boott anticipates conducting a working group meeting with stakeholders to discuss scenarios to be simulated. Boott provided potential simulation runs in the RSP, but information from the telemetry studies may be used to better inform the simulated conditions of the CFD models.

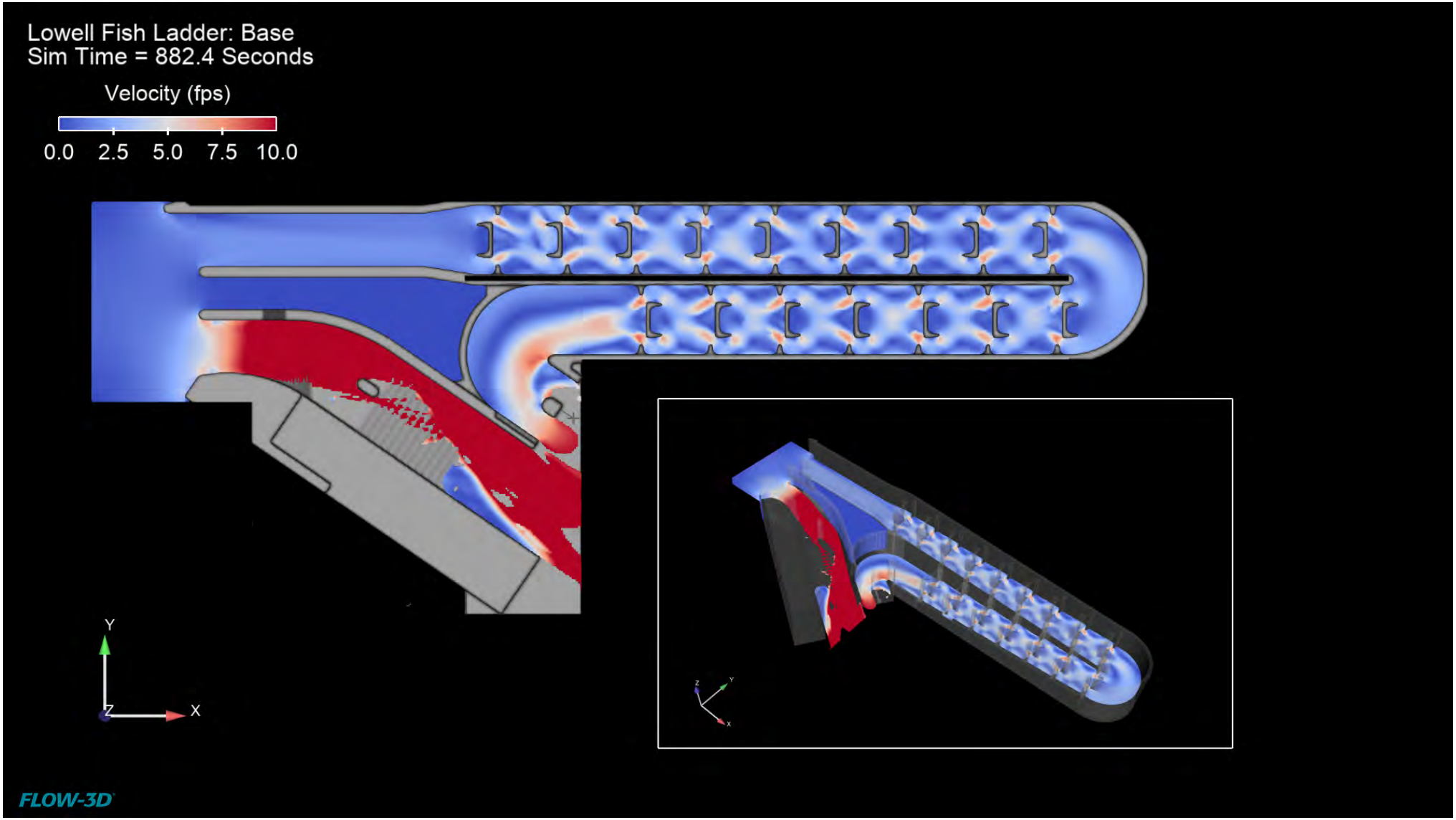
8 Literature Cited

Flow Science, Inc. (2019). *User Manual: FLOW-3D Documentation, Release 12.0.0.* Albuquerque: Flow Science, Inc.

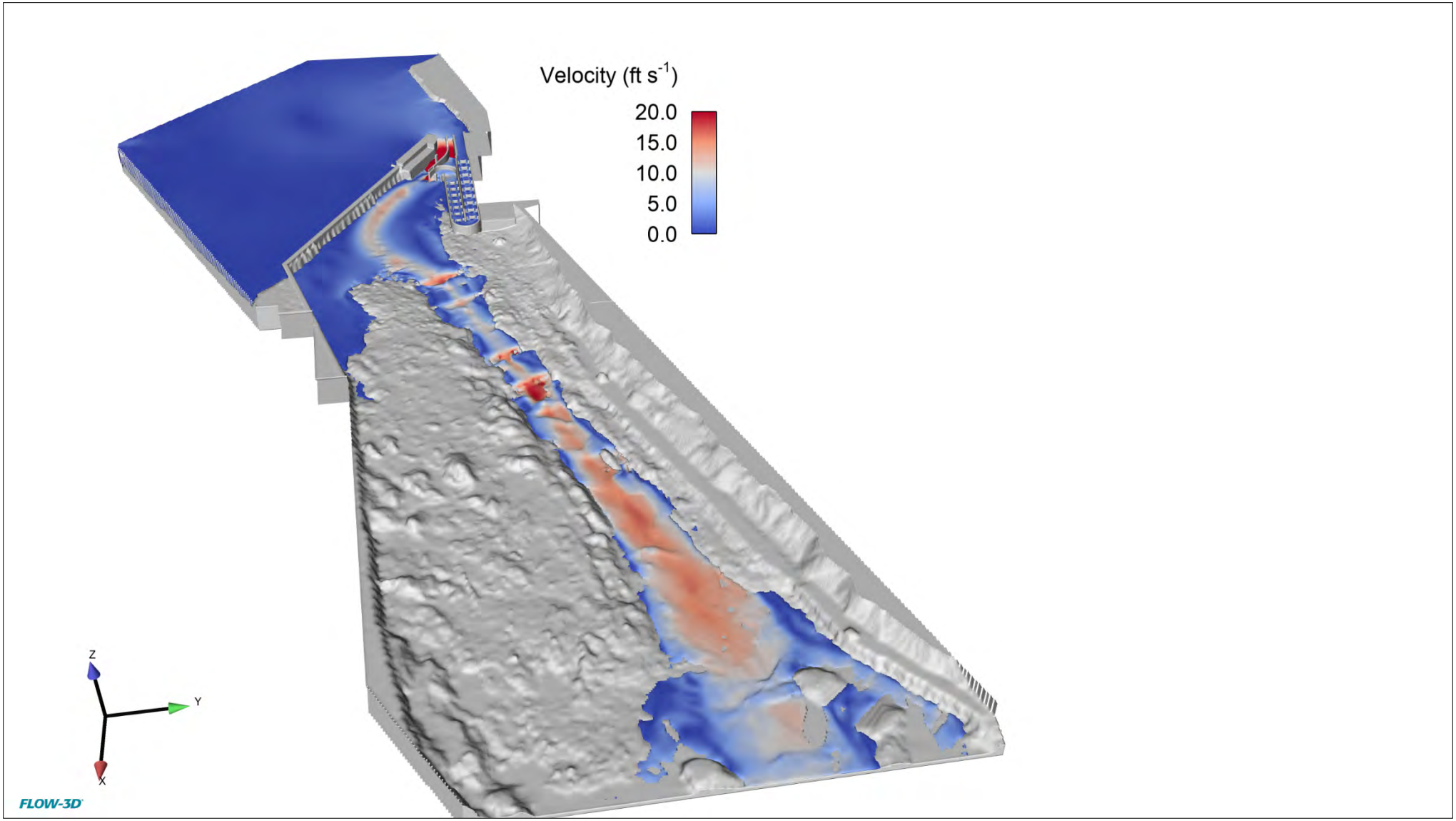
Hirt, C. W., & Nichols, D. B. (1981). Volume of Fluid (VOF) Method for the Dynamics of Free Boundaries. *Journal of Computational Physics*, 201-225.

Orszag, S. A., & Yakhot, V. (1986). Renormalization Group Analysis of Turbulence. *International Congress of Mathmaticians* (pp. 1395-1399). Berkley: Princeton University.

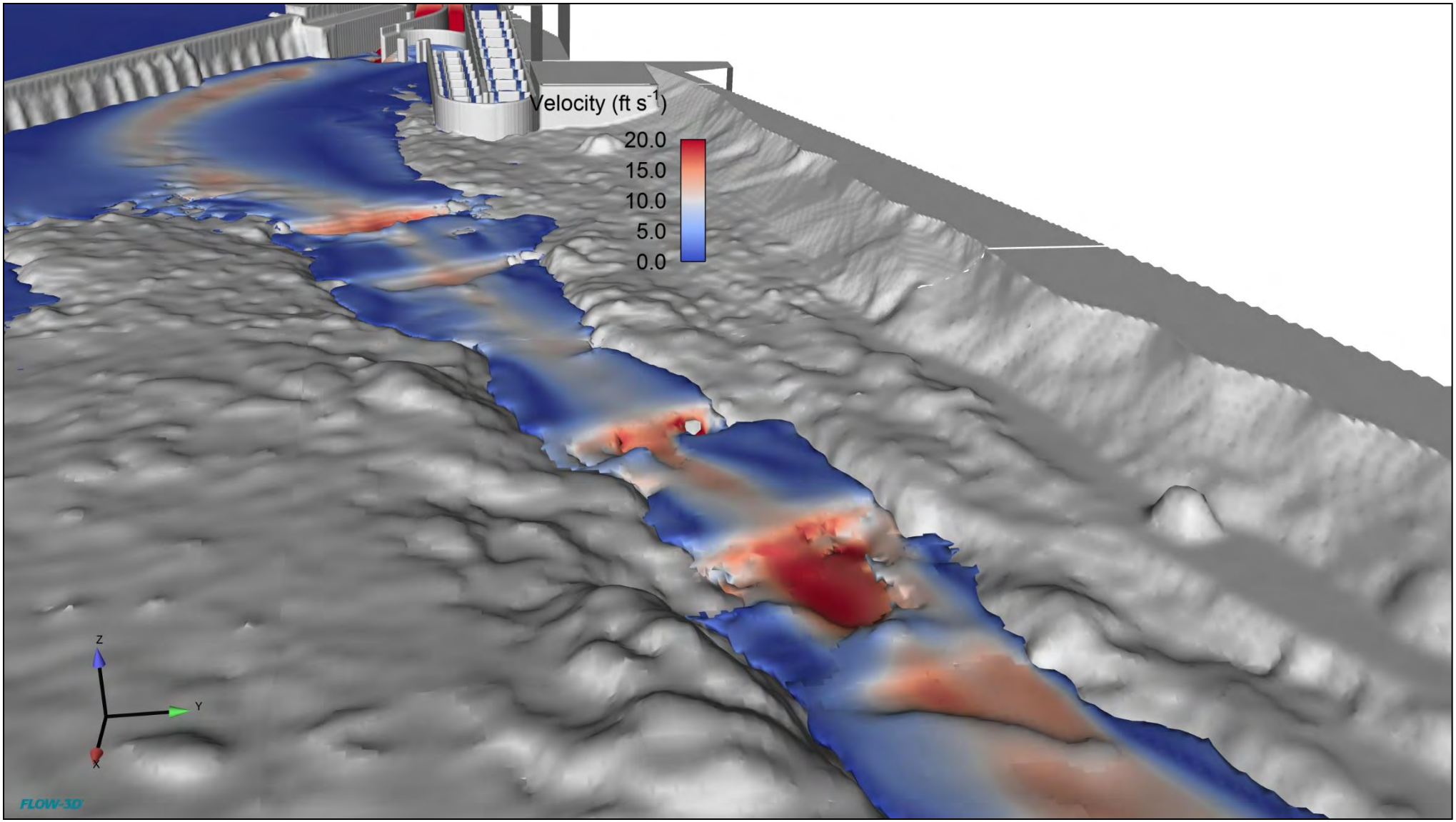
Appendix A
Preliminary Fish Ladder CFD Model Results



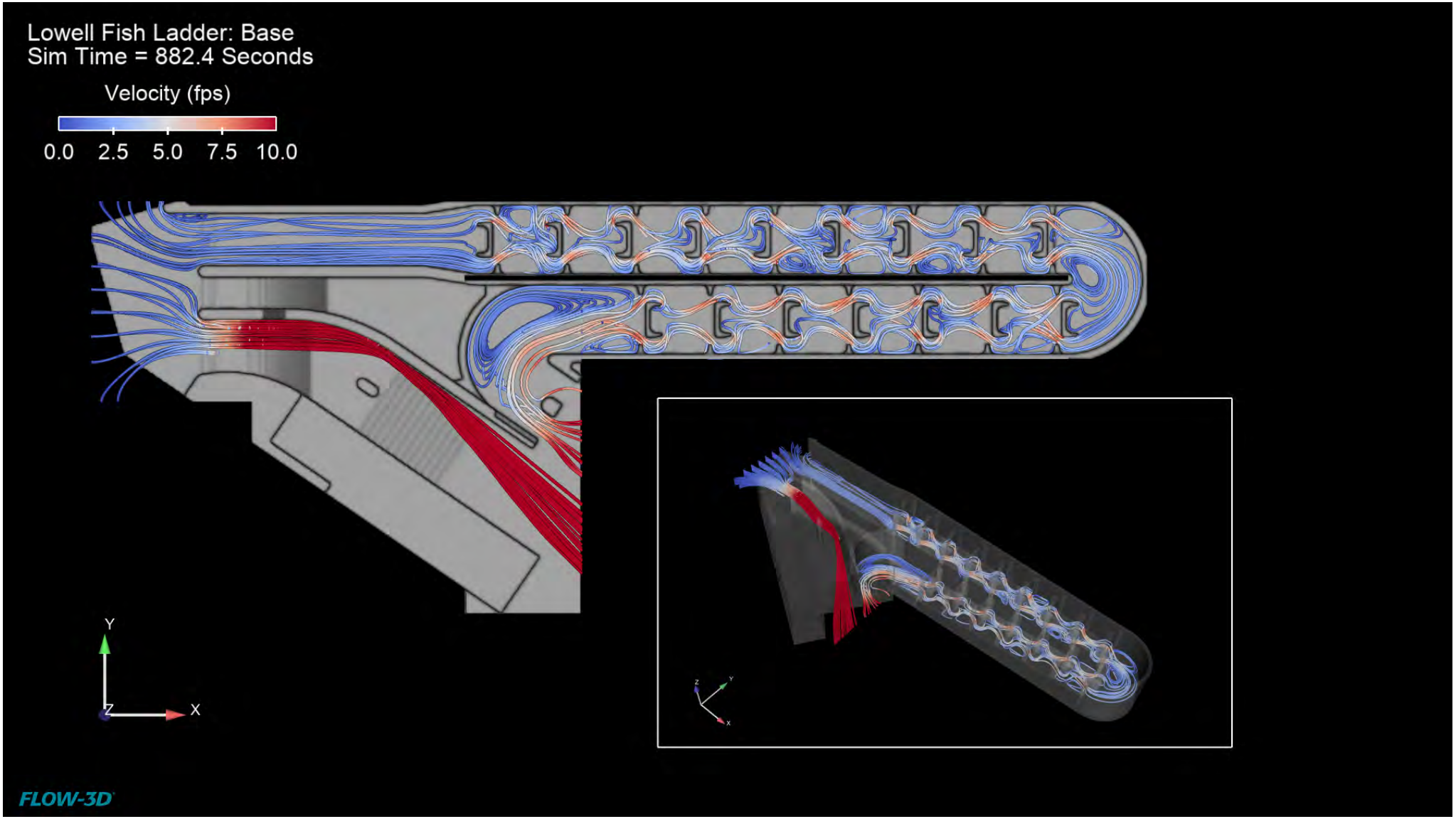
Fish Ladder CFD Model Preliminary Results



Fish Ladder CFD Model Preliminary Results

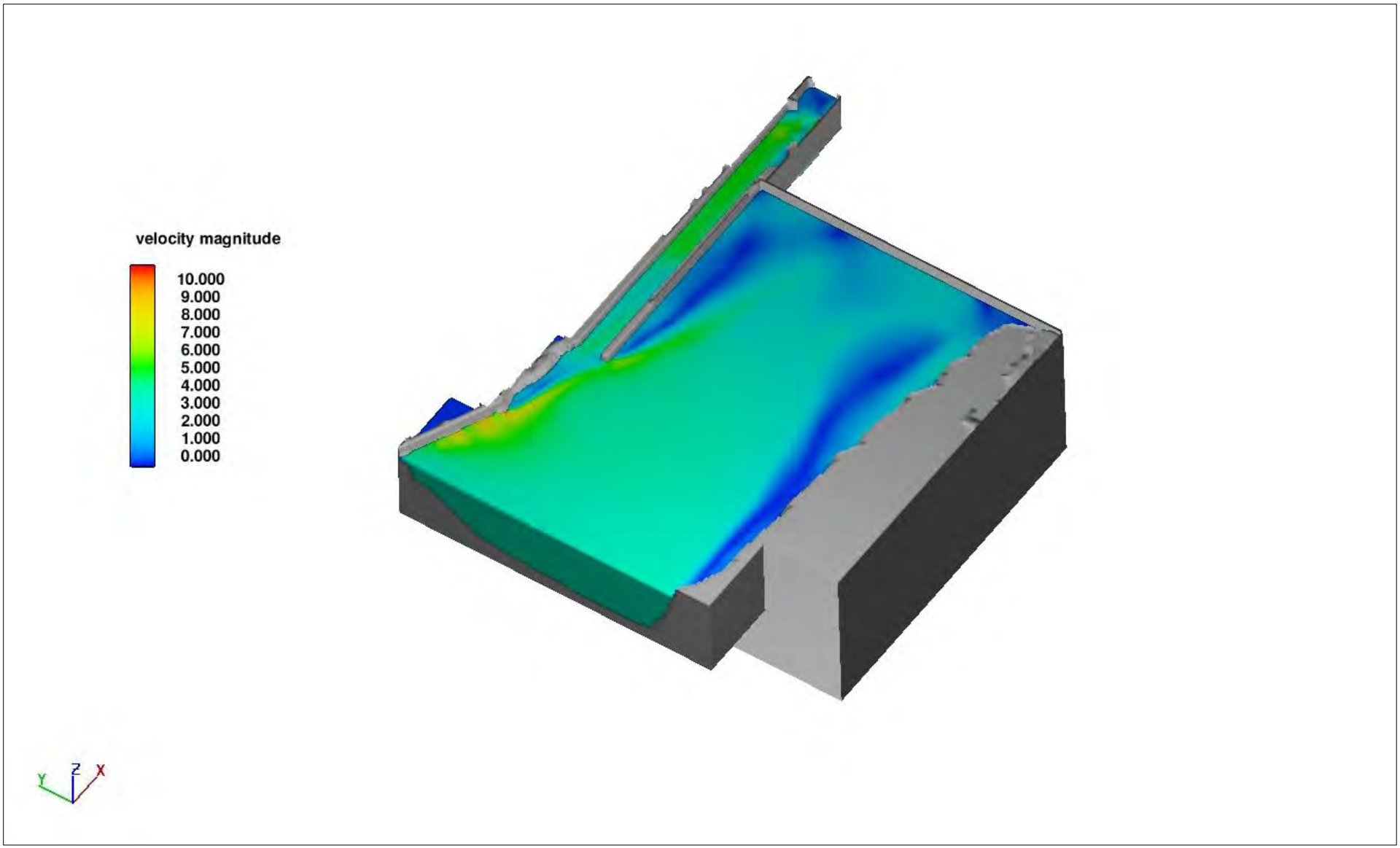


Fish Ladder CFD Model Preliminary Results



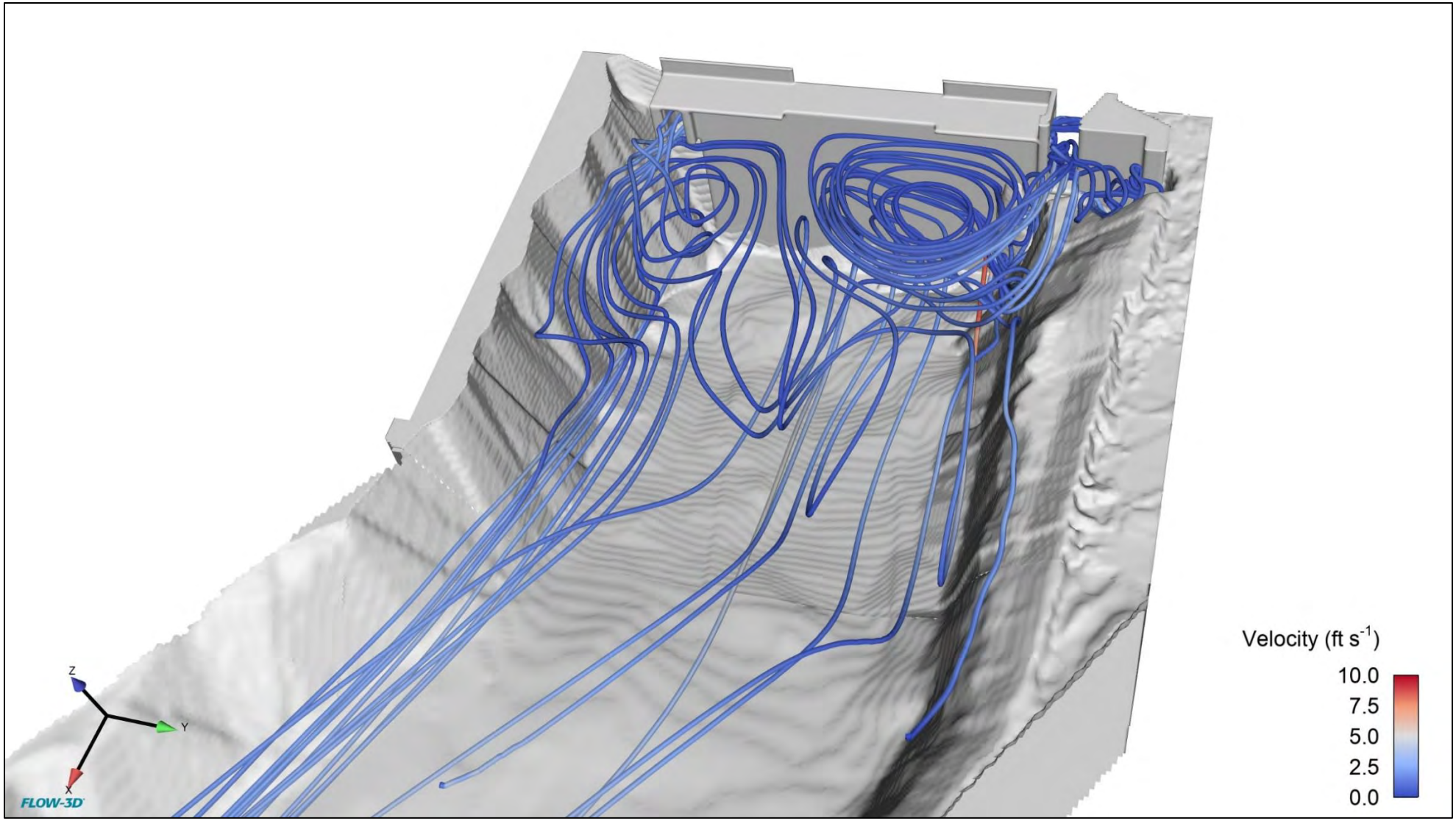
Fish Ladder CFD Model Preliminary Results

Appendix B
Preliminary E.L. Field Powerhouse CFD Model Results



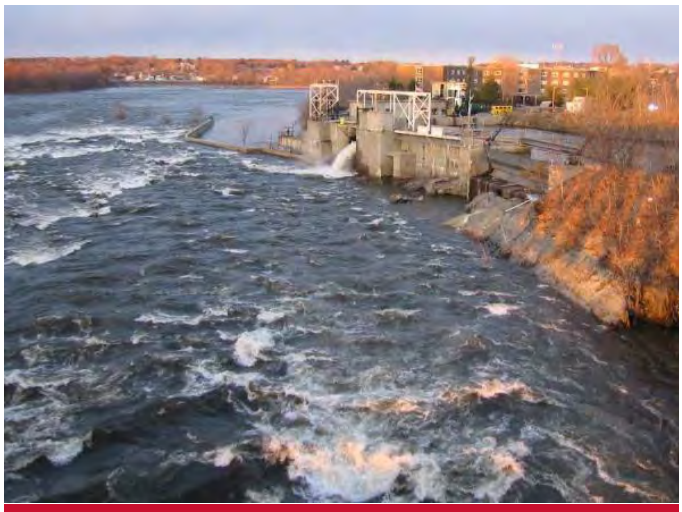
E.L. Field Powerhouse Forebay Preliminary Results

Appendix C
Preliminary Tailrace CFD Model Results



Tailrace Preliminary CFD Model Results

Note: The geometry and flow locations of the tailrace were created from original engineering drawings. Flow does not cross over to exit the river right (looking downstream) side of the powerhouse, those sections have been closed since original construction. This will be fixed in the next submittal to be expected by March 30, 2021.



Operation Analysis of the Lowell Canal Study

Lowell Hydroelectric Project (FERC No. 2790)

February 25, 2021

Prepared by:

HDR

Prepared for:

Boott Hydropower, LLC
Manchester, New Hampshire

Central Rivers Power

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Contents

Tables

Figures

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List of Acronyms

Boott	Boott Hydropower, LLC (or Licensee)
CFR	Code of Federal Regulations
cfs	cubic feet per second
FERC	Federal Energy Regulatory Commission (or Commission)
ILP	Integrated Licensing Process
kW	kilowatt
MW	megawatt
NGVD 29	National Geodetic Vertical Datum of 1929
Project	Lowell Hydroelectric Project (or Lowell Project)
Proprietors	Proprietors of the Locks and Canals
RM	river mile
ROR	run-of-river
SPD	Study Plan Determination

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1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20.2-megawatt (MW) Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (CFR) Part 5.

In accordance with 18 CFR §5.15, Boott has conducted studies as provided in the study plan and schedule approved in the Commission's March 13, 2019 Study Plan Determination (SPD) for the Project.[1] This report describes the methods and results of the approved Operation Analysis of the Lowell Canal Study.

1.1 Project Description and Background

The Lowell Project is located at river mile (RM) 41 on the Merrimack River in the City of Lowell in Middlesex County, Massachusetts, with an impoundment extending approximately 23 miles upstream into Hillsborough County, New Hampshire. The existing Lowell Project consists of:

1) A 1,093-foot-long, 15-foot-high masonry gravity dam (Pawtucket Dam) that includes a 982.5-foot-long spillway with a crest elevation of 87.2 feet National Geodetic Vertical Datum 1929 (NGVD 29) topped by 5-foot-high, pneumatically-operated crest gates deployed in five independently-operable zones;
2) A 720-acre impoundment with a normal maximum water surface elevation of 92.2 feet NGVD 29;
3) A 5.5-mile-long canal system which includes several small dams and gatehouses;
4) A powerhouse (E.L. Field) which uses water from the Northern Canal and contains two turbine-generator units with a total installed capacity of 15.0 MW;
5) A 440-foot-long tailrace channel;
6) Four powerhouses (Assets, Bridge Street, Hamilton, and John Street) housed in nineteenth century mill buildings along the Pawtucket, Hamilton, and Eastern canal systems containing 15 turbine-generator units with a total installed capacity of approximately 5.1 MW;

[1] The Commission issued a Revised Process Plan and Schedule on June 12, 2020.

7) A 4.5-mile-long, 13.8-kilovolt transmission line connecting the powerhouses to the regional distribution grid;

8) Upstream and downstream fish passage facilities including a fish elevator and downstream fish bypass at the E.L. Field powerhouse and a vertical-slot fish ladder at the Pawtucket Dam; and

9) Appurtenant facilities.

At the normal pond elevation of 92.2 feet NGVD 29 (crest of the pneumatic flashboards), the surface area of the impoundment encompasses an area of approximately 720 acres. The gross storage capacity between the normal surface elevation of 92.2 feet and the minimum pond level of 87.2 feet is approximately 3,600 acre-feet.

The Project operates in a run-of-river (ROR) mode using automatic pond level control capability of the E.L. Field Powerhouse and has no usable storage capacity. Boott normally operates the Project to maximize flow through the available units at the E.L. Field Powerhouse, then routes any additional flows through the Pawtucket Canal system. The E.L. Field turbine-generator units are more efficient and operate at a higher head than the older canal units and are, therefore, the priority first-on, last-off units in the Project operations scheme. When river flows exceed the hydraulic capacity of the E.L. Field units (approximately 3,300 cubic feet-per-second [cfs] per unit or 6,600 cfs for both units), excess flows up to approximately 2,000 cfs are routed through the downtown canal system and to the canal units. Any flows in excess of approximately 8,600 cfs (6,600 cfs at E.L. Field plus 2,000 cfs via canals) are passed over the Pawtucket Dam spillway. Pursuant to Article 37 of the existing FERC license, the Project maintains a minimum flow of 1,990 cfs or inflow, whichever is less, as measured immediately downstream from the Project.

On December 2, 2020, Boott filed a Draft License Application (DLA) with the Commission pursuant to 18 CFR §5.16(a). As described in the DLA, Boott is proposing to remove the four canal power stations (Assets, Bridge Street, Hamilton, and John Street) and associated canal infrastructure from the new FERC license. Operation of the canal units is no longer economically feasible, and Boott is not proposing to continue generation at these four developments. Boott will continue to manage the canal structures, water levels, and flows using best practices and consistent with current agreements with the National Park Service and other stakeholders.

2 Study Goals and Objectives

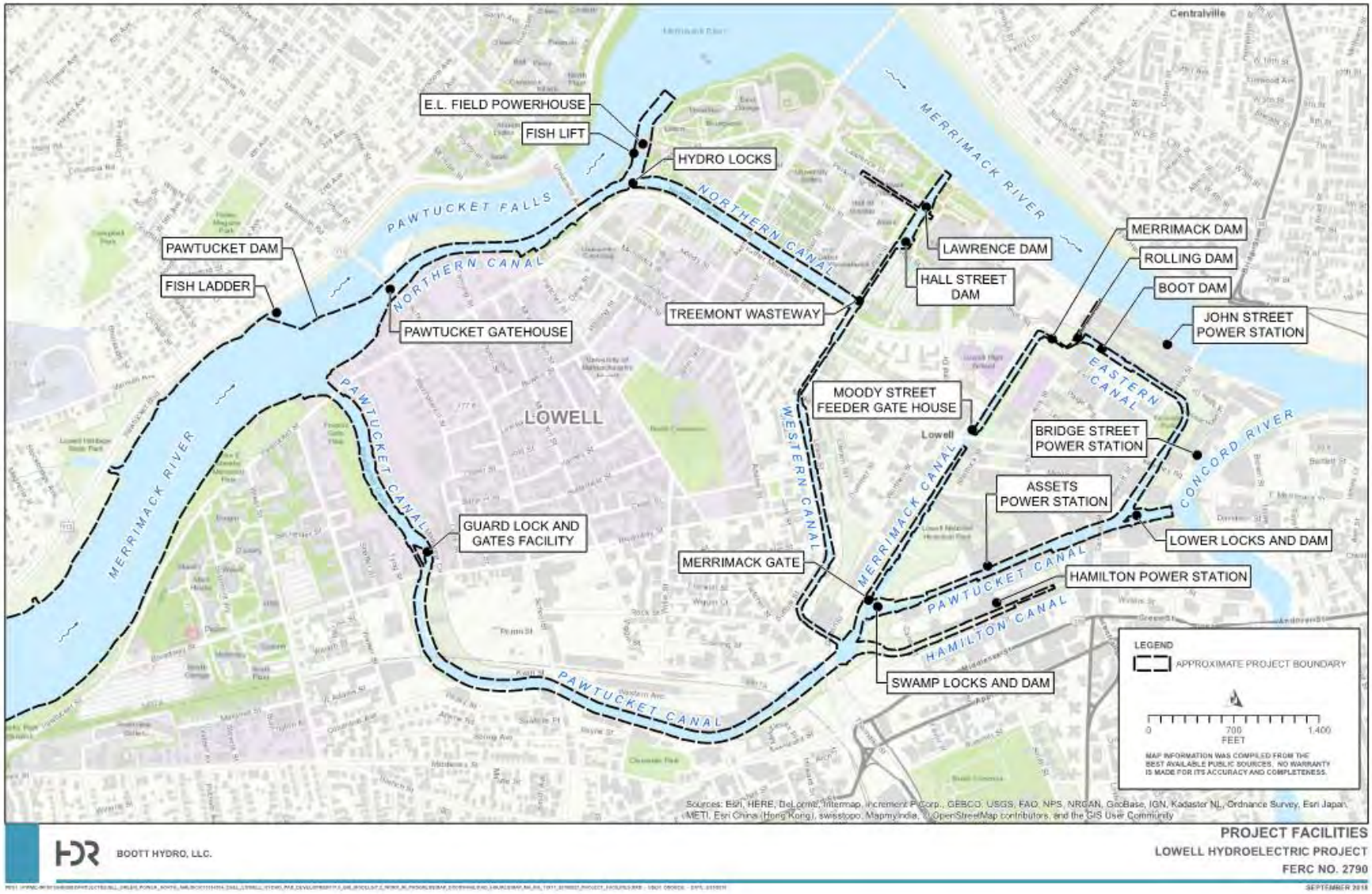
The goal of this study is to understand the operations of the Project's canal system. The specific objective of this study is to describe, to the extent possible, the operations of the canal system, which include, but are not limited to:

- How all of the canal units interact with the main units at the E.L. Field Powerhouse;
- How the canal units are sequenced;
- How often each of the canal units operate;
- The prioritization sequence of canal unit operations; and
- The amount of time the canal units are operated during the downstream passage season.

3 Study Area

The study area for the Operation Analysis of the Lowell Canal Study includes the Project's canal system and powerhouses located in the City of Lowell (Figure 3-1).

Figure 3-1. Existing Project Boundary and Facilities of the Lowell Canal System



4 Methodology

4.1 Literature Review

Boott conducted a desktop file review to examine current Project operational protocols and historical canal operations data. The canal units have experienced repeated maintenance issues, and generation is marginal, inefficient, and uneconomical under current conditions. Several of the canal system units have experienced prolonged outages in recent years, and the canal system as a whole has not been operated for purposes of generation in more than a year.

Historically, it has not been Boott's practice to log or otherwise record which of the individual canal units or powerhouses were in operation on a daily basis. As such, Boott does not have records of when individual canal powerhouses or units were operating. In general, operational data for the canal system is limited, and recent changes in both Project ownership and staffing have further compounded this issue.

To address the goals and objectives of this study, Boott reviewed data from a 10-year period of typical canal unit operations from 1998 – 2007. Data from this period was utilized in this analysis as it represented a relatively normal period of canal operations in which many (although not necessarily all) of the canal units were available for dispatch at Merrimack River flows in excess of 6,600 cfs capacity of the E.L. Field Powerhouse units. While the dataset does not indicate which specific units or powerhouses were operating, it does include aggregate records of generation (in kilowatts [kW]) for the downtown canal system recorded at 08:00 AM on a daily basis for the period of record. This data can be used to estimate how often canal units were operated on an annual basis and during downstream passage seasons. Because generation was reported in the aggregate, it is not possible to determine specifically which units or combination of units were in operation on a daily basis. Similarly, the dataset provides only a "snapshot" of daily generation at 08:00 AM; therefore, the data does not provide information on intra-daily changes in generation. However, Boott believes that this dataset provides a means of characterizing generation trends in the Project's canal system annually and for downstream passage seasons.

5 Study Results

5.1 Project Generating Units

At present, the Project includes a total of 17 generating units, including two units at the E.L. Field Powerhouse and 15 units at the downtown canal powerhouses. Generating unit characteristics are summarized in Table 5-1.

Table 5-1. Lowell Project Generating Unit Characteristics

Powerhouse	Unit #	Type	Size (Inches)	Speed (RPM)	Net Head (Feet)	Flow Rate (cfs)	Power (HP)	Power (kW)
E. L. Field	1	Fuji Horizontal Full Kaplan	152.4	120	39	3,300	11,540	7,506
E. L. Field	2	Fuji Horizontal Full Kaplan	152.4	120	39	3,300	11,540	7,506
Assets	1	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444	265
Assets	2	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444	265
Assets	3	Hercules Double Runner Styles C & D	33 and 31	150	13	376	444	265
Bridge Street	4	Hercules Type D Single Runner	42	138.5	22	333	655	360
Bridge Street	5	Hercules Type D Single Runner	42	138.5	22	333	655	360
Bridge Street	6	Hercules Type D Single Runner	42	138.5	22	333	655	360
Hamilton	1	Leffel Type Z Single Runner	45	120	13	374	459	280
Hamilton	2	Leffel Type Z Single Runner	39	133	13	279	341	190
Hamilton	3	Leffel Type Z Single Runner	36	150	13	237	287	160
Hamilton	4	Leffel Type Z Single Runner	45	120	13	374	459	280
Hamilton	5	Leffel Type Z Single Runner	45	120	13	374	459	280
John Street	3	Leffel Single Runner	33	200	21	250	482	300
John Street	4	Leffel Single Runner	33	200	21	250	482	300
John Street	5	Leffel Single Runner	33	200	21	250	482	300
John Street	6	Allis Chalmers Single Runner	72	100	21	1,000	1,925	1,200

5.2 Project Operations and Unit Dispatch Sequence

5.2.1 General Project Operations

As noted above, the Project operates in a ROR mode with no usable storage capacity. The two generating units at the E.L. Field Powerhouse are the most efficient units and are, therefore, the priority first-on, last-off units. It has been Boott's practice to dispatch the canal units when Merrimack River flows exceed the combined 6,600 cfs hydraulic capacity of the units at the E.L. Field Powerhouse. At flows higher than 6,600 cfs, Boott would typically divert up to 2,000 cfs to the canal units. Flows higher than 8,600 cfs (the combined capacity of the E.L. Field Powerhouse and the canal units) are spilled over the Pawtucket Dam spillway and into the Project's bypass reach.

5.2.2 Canal Unit Dispatch Sequence

In general, the canal unit dispatch sequence is intended to maximize the efficiency of units. Due to the imbalance of unit flow capacities between the units along the Hamilton Canal and the lower Pawtucket and Eastern canals, the Hamilton units would generally be the first units to be dispatched at Merrimack River flows in excess of 6,600 cfs. The Bridge Street units along the lower Pawtucket Canal and the John Street units along the Eastern Canal would then typically be sequenced to match the operating Hamilton canal units.

Notwithstanding this ideal unit dispatch sequence, Boott notes that the canal units have not been operated regularly in many years due to maintenance issues and other factors. In practice, the historical sequence for individual unit dispatch in each canal powerhouse has varied considerably depending on maintenance issues and unit operability. Historically, operators evaluated individual units based on flow conditions, operating efficiency, safety factors, and maintenance conditions prior to dispatching units for generation. As noted above, the canal units have not been operated in more than a year.

5.2.3 Historical Canal Unit Operations

As discussed in Section 4.1 of this study report, there is limited historical operations data available for the Project's existing downtown canal units. Boott analyzed aggregate canal unit generation data from a 10-year period of typical canal operations (1998 – 2007) to characterize operation of the Project's canal units. Boott also analyzed canal unit operations during the May – July fish passage season for spent alosines and the August – November fish passage season for adult eels and juvenile alosines. This analysis is indicative of the percent of time the canal units would be expected to operate each month under normal operating conditions.

Based on this analysis, the Project's canal units were operated on 34 percent of days during the total period of record (January 1, 1998 – December 31, 2007). The Project's canal units were operated on 40 percent of days during the May – July fish passage

season and on 15 percent of the days during the August – November fish passage season. Table 5-2 summarizes operation of the canal units by year.

Table 5-2. Percentage of Days Canal Units were Operated by Year (1998 – 2007)

Year	Total Annual Percentage of Days Canal Units were Operated	Percentage of Days Canal Units were Operated May – July	Percentage of Days Canal Units were Operated August – November
1998	37%	54%	1%
1999	30%	7%	19%
2000	30%	38%	2%
2001	17%	24%	0%
2002	27%	49%	3%
2003	40%	36%	37%
2004	45%	35%	30%
2005	64%	78%	48%
2006	29%	53%	7%
2007	18%	30%	8%

Boott also analyzed the operations of the Project's canal units on a monthly basis for the period of record, as shown in Table 5-3.

Table 5-3. Percentage of Days Canal Units were Operated by Month (1998 – 2007)

Month	Percentage of Days Canal Units were Operated
January	31%
February	23%
March	52%
April	81%
May	62%
June	43%
July	16%
August	6%
September	12%
October	15%
November	29%
December	35%

Finally, Boott conducted an analysis to determine the total number of days per month that the canal units were operated during the 10-year period of record, as shown in Table 5-4.

Table 5-4. Number of Days Canal Units were Operated by Month and Year

Month	Year									
	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*
Jan	8	12	2	0	0	3	9	31	31	0
Feb	14	21	7	0	1	0	0	11	12	0
Mar	31	30	30	9	15	11	27	2	0	5
April	30	17	30	30	25	30	30	30	7	15
May	15	6	30	8	27	24	21	27	6	28
Jun	20	0	5	14	17	9	11	27	27	0
Jul	15	0	0	0	1	0	0	18	16	0
Aug	0	0	2	0	0	11	4	0	2	0
Sep	0	9	0	0	0	2	19	5	0	0
Oct	0	10	0	0	0	8	5	23	0	1
Nov	1	4	0	0	4	24	8	30	6	9
Dec	0	2	5	0	9	24	31	29	0	7

6 Summary and Discussion

The Lowell Project's canal generating units have experienced maintenance issues that have prevented normal operation of the units for the past several years. Limited operational data is available for the canal units, and it has not been Boott's practice to record individual canal unit or powerhouse start/stop times or daily generation. In order to address the goals and objectives of the Operation Analysis of the Lowell Canal Study, Boott reviewed available data from a period of relatively normal canal unit operations (1998 – 2007) to characterize how often the canal units were operated on an annual basis and during the May – July and August – November downstream fish passage seasons. Based on the available data, canal unit operations varied considerably from year-to-year. In general, this can be attributed to two primary factors:

- **Merrimack River Flows:** Boott prioritizes generation at the E.L. Field Powerhouse, and the downtown canal units are not dispatched until Merrimack River flows exceed the combined 6,600 cfs hydraulic capacity of the E.L. Field Powerhouse's two generation units;
- **Unit Maintenance and Operability:** The majority of the canal units were last upgraded in the 1940s and are now almost 80 years old. These units are routinely out-of-service for maintenance or because they are simply inoperable.

As discussed in Boott's December 2, 2020 DLA for the Project, operation of the canal units is no longer economically feasible, and Boott has proposed to remove the downtown developments (Assets, Bridge Street, Hamilton, and John Street) from the Project's FERC license. Boott is not proposing to restart or continue generation at these four developments.

7 Variances from FERC-Approved Study Plan

The Operation Analysis of the Lowell Canal Study was conducted in full accordance with the methods described in the FERC-approved study plan except for the following variances:

- The approved study plan directs Boott to describe how often each of the canal units operate and the amount of time canal units operate during the downstream passage season. As discussed in this study report, it has not been Boott's practice to record individual canal unit operations or document unit start/stop times. Accordingly, Boott reviewed and analyzed records from a period of relatively normal canal unit operations that reflect a daily "snapshot" of aggregate canal unit generation.