
# Tennessee State Parks Trail Assessment

## Data Driven Sustainable Trail Management

Tennessee Department of Environment & Conservation | Report | May 2018

# Executive Summary

A trail system is most effective when it is based on sustainable trail design and maintenance. Tennessee State Parks assessed all trails within our parks system, with the exception of the Justin P. Wilson Cumberland Trail, in order to better understand what current trail issues exist and where they lie spatially within our system (the Cumberland Trail was exempt from this assessment due to it still being under construction). This report focuses on the methodology in which the assessment was conducted, the analyzation of the data that was collected, and the suggested method in which to correct the identified issues. As with the nature of nature, the data that was collected is subject to change. However it is seen that this report is still a valid representation of the trail system condition of Tennessee State Parks.

## *Key Findings*

- Most unsustainable trail problems are directly related to the original trail design and layout.
- Many of Tennessee State Parks' trails were built before the 1990s, which was when sustainable trail building information and education became more accessible.
- Bridge Inspections are irregular and not standardized
- Ability to repair and replace trails to meet sustainable standards in a timely manner may not be possible with current staffing patterns.
- Many of our trails untilize old road beds due to ease of construction, which is important with our limited staffing. However, these are often maintenance nightmares.

Big Cypress Tree State Park, 2016

# Tennessee State Parks Trail Assessment: Data Driven Sustainable Trail Management

## *Introduction*

There is a science to trail building, just as there is to any other structure that is built for human use. Building trails while taking into account hydrology, ecology, and human nature, among other things, is considered sustainable trail building. This type of building combines a wealth of knowledge derived from sources such as the Civilian Conservation Corps of the 1930s, the U.S. Forest Service of the 20th Century, and even road builders from ancient Rome.[1]

> *Redesign and reroutes are often the most effective tools...*

Unfortunately, for many centuries sustainable trail building was reserved for talented trail builders that were thinly spread across the globe and did not often make its way into mainstream recreational use trails. This lack of knowledge has led to a mass network of unsustainable trails that cost millions of dollars annually to maintain, not to mention the increased likelihood of injuries on these incorrectly built trails. Regrettably, Tennessee State Parks is not exempt from these lackluster trail designs and has regular and reoccurring trail problems.

The most effective way of decreasing the overall amount of trail maintenance needed is to design and build sustainable trails.[2] Trails that are not sustainably built can have features added to them to make them more sustainable, such as erosion and user control devices. However, these are only “Band-Aids” to the actual problem. The goal of the statewide trail assessment was to document areas of concern within the system, and to help identify the most viable solutions. Though redesign and reroutes are often the most effective tools, they are not always possible solutions for trail problem mitigation. The largest hurdles to reroutes and redesign include, but are not limited to: land boundaries, species of special concern, staffing limitations, and funding opportunities.

**1,2.** IMBA, Trail Solutions: IMBA’s Guide to Building Sweet Singletrack (Boulder: International Mountain Bicycling Association, 2004), 13

## *How Much Data Was Collected?*

Over the duration of the trail assessment almost 3,000 individual data points were taken in the field. These data points were made up of a mix of trail maintenance issues, trail bridges, trail signage, and designated trail heads. All of these spatial locations have an abundance of data tied to them such as the condition of a bridge, amenities available at a trail head, or a potential solution for a trail maintenance issue. For more detailed information on the methodology used for the data collection, please see Attachment A.

> *All of these spatial locations have an abundance of data tied to them*

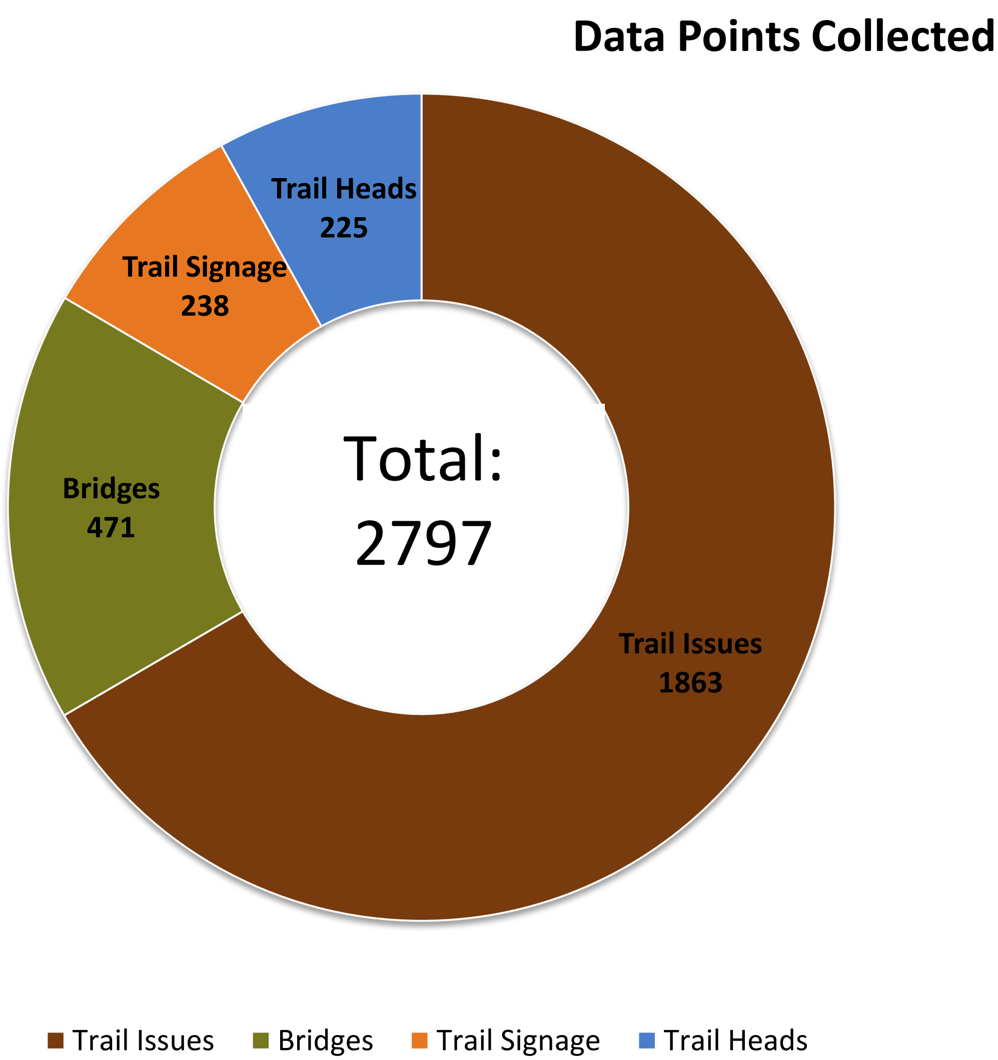



**Figure 2.** Number of data points collected separated by measurement type.

## *What do these data points tell us?*

This data allows us to see our system of trails from a whole new perspective. With 471 trail bridges assessed we know that we have an average of **8 bridges per park**. At 225 trail heads we can establish that there is, on average, a **trail head for every 4 miles of trail** in our parks. And the most important measurement of all tells us that with 1,860 identified trail issues, Tennessee State Parks' trail system has an **unsustainable trail problem approximately every .47 miles**.

*Tennessee State Parks' trail system has an unsustainable trail problem every .47 miles.*

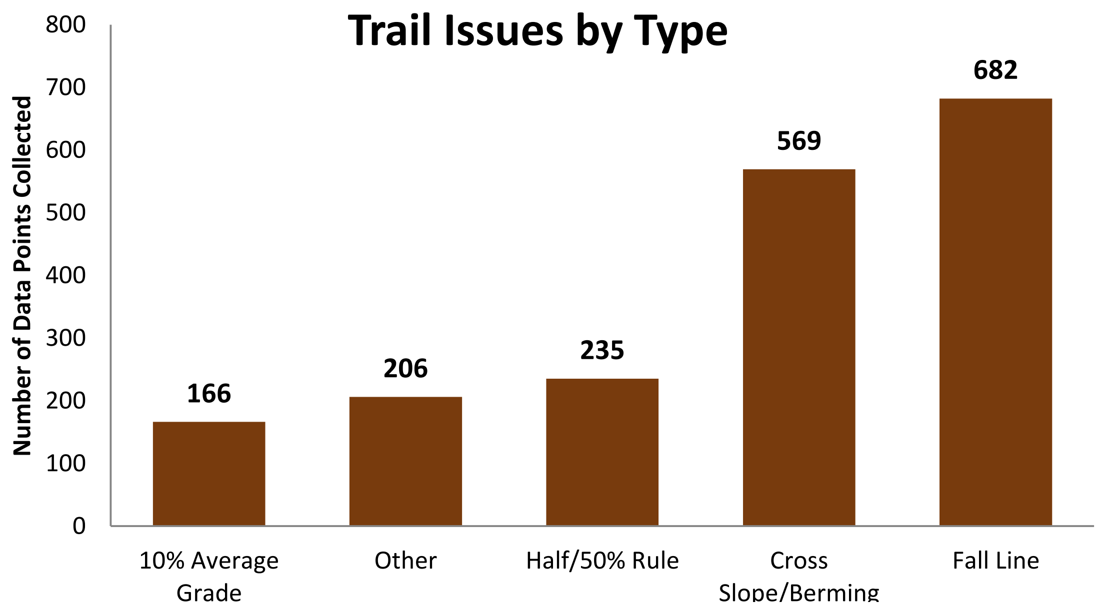



**Figure 2.** Collected trail issues separated by cause.

Window Cliffs State Natural Area, 2016

## *How long will it take to correct these issues?*

Trail work is not only a feat of engineering and hydrologic management, but it is also an art form of sorts. Due to the physically demanding construction, remote locations, and creativity needed, trail work usually takes longer than other construction projects similar in size. In addition to that, hiring professional trail builders to do the work can be very difficult due to the low number of them. Though even when a trail contractor is found, often times they are not financially feasible. Conservatively, it is estimated to take somewhere around **30,000 hours** to correct all of the identified trail issues. If the current trails program staff were to take this work on it would take over **15 years** to complete. If a state wide trails staff was increased, that timeline would be dramatically reduced. Divided up by park, each would have about **545 hours** of trail maintenance to do; and if divided up by rangers, each ranger would have about **204 hours** of trail maintenance. However, this is just an average and is not exactly representative of all parks and rangers. Some will have dramatically more trail work than others due to their size and recreational facilities (i.e. South Cumberland vs Sycamore Shoals). These estimates do not include travel time. Though that plays a very important part in trail maintenance, it varies widely from park to park and is difficult to accurately predict. For more detailed information on the methodology used for this data analyzation, please see Attachment B.

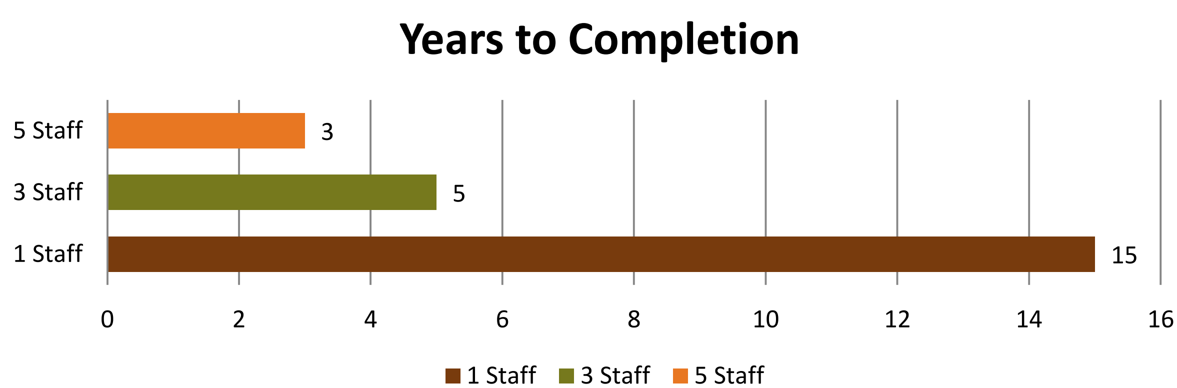



**Figure 3.** Conservative number of years needed to repair all trail issues if completed by trails program with different staffing levels.

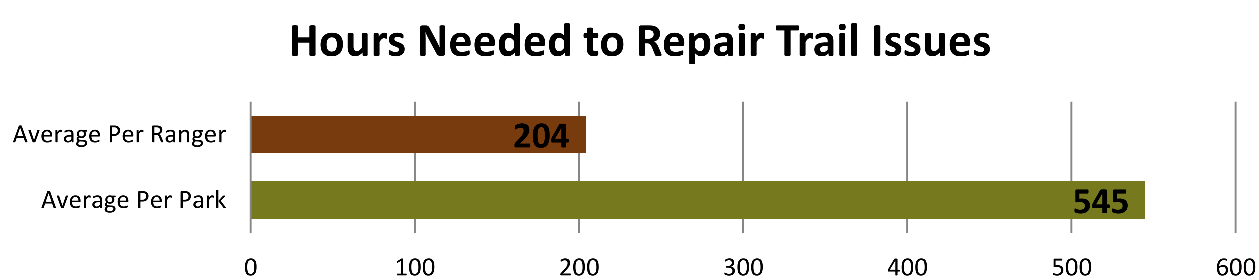



**Figure 4.** Average hours needed to repair trail issues by park and by ranger.

## *What is the cost to repair all identified issues?*

> *These costs combine to a minimum total of about $850,000 needed to repair all identified trail issues.*

As with everything else, trail work costs money. Between employee hours and physical materials it can quickly get very expensive. Currently, if all the work is to be done with park staff only, it would cost approximately **$663,300 in wages** alone. [3] However, it must be recognized that park staff members wear many hats, and that fully concentrating on trail maintenance all of the time isn't always a possibility. Therefore, sometimes professional trail builders must be utilized to have things done in a timely manner. If these professionals were used to complete all work it would cost approximately **$2,156,250 in wages**. [4] These costs do not include things such as travel and mobilization fees, as those costs can widely vary.

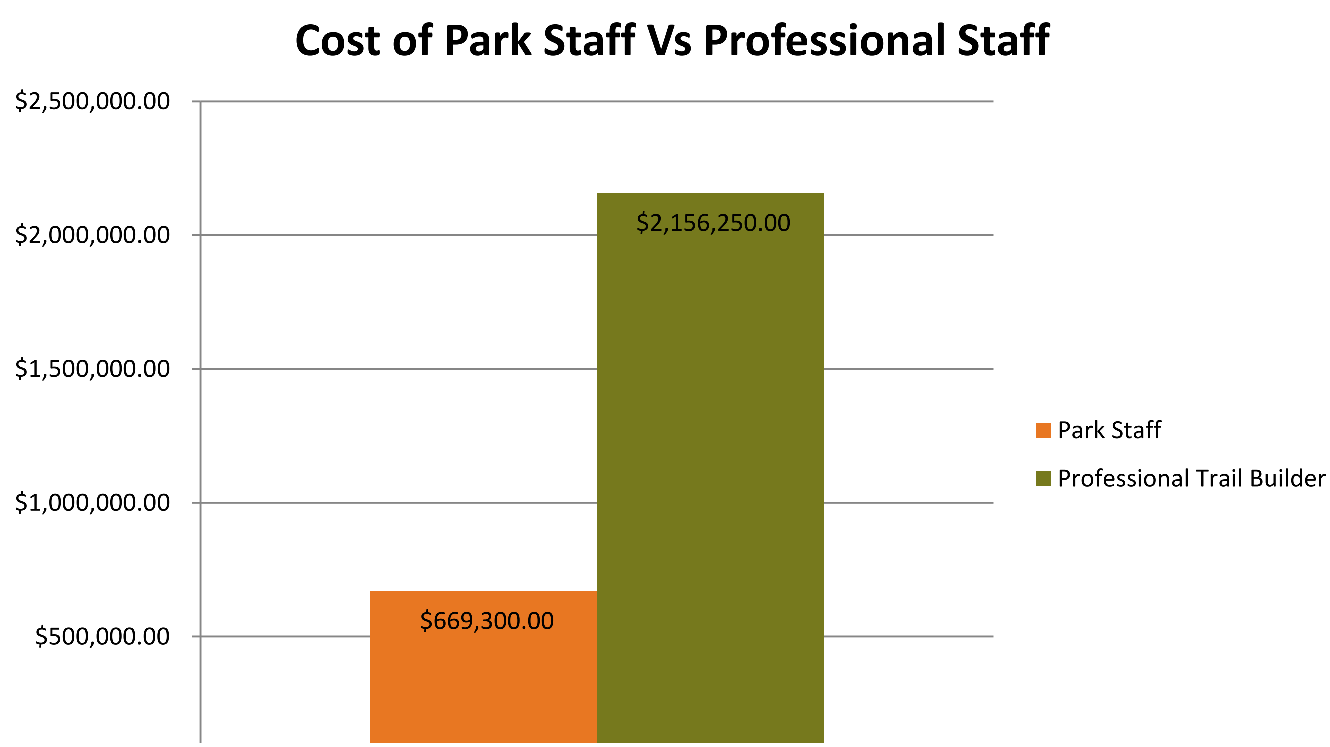



**Figure 6.** Comparison of the minimum cost difference for fixing trail issues between park staff and professional staff.

**3.** Park staff wage cost was calculated using an average hourly rate of $19.40/Hr. This number was provided by TN Department of Human Resources. A 15% contingency was added for inflation and unforeseen costs.

4. Professional trail builder wage cost was calculated using an average hourly rate of $62.50. This number was calculated by averaging local professional hourly rates. A 15% contingency was added for inflation and unforeseen costs.

In addition to the wages, **$188,713 in materials** would be needed. This includes things like lumber, concrete, blazes, and specialty work that would have to be contracted out (i.e. asphalt). This is a conservative estimate, as materials prices change not only year to year, but throughout the year depending on the season. This materials estimate was calculated using past and current projects as a baseline along with a 15% contingency for inflation and unforeseen circumstances.

These costs combine to a minimum total of about **$850,000** needed to repair all identified trail issues. As stated earlier, these numbers are an accurate, but very conservative, estimate if most work is completed by park staff. If professional trail builders are used these cost estimates would be, at minimum, 2.5 times higher. Though the cost is more to contract professionals, the timeline would be dramatically decreased. For more detailed information on the methodology used to calculate hours and materials needed, please see Attachment B.

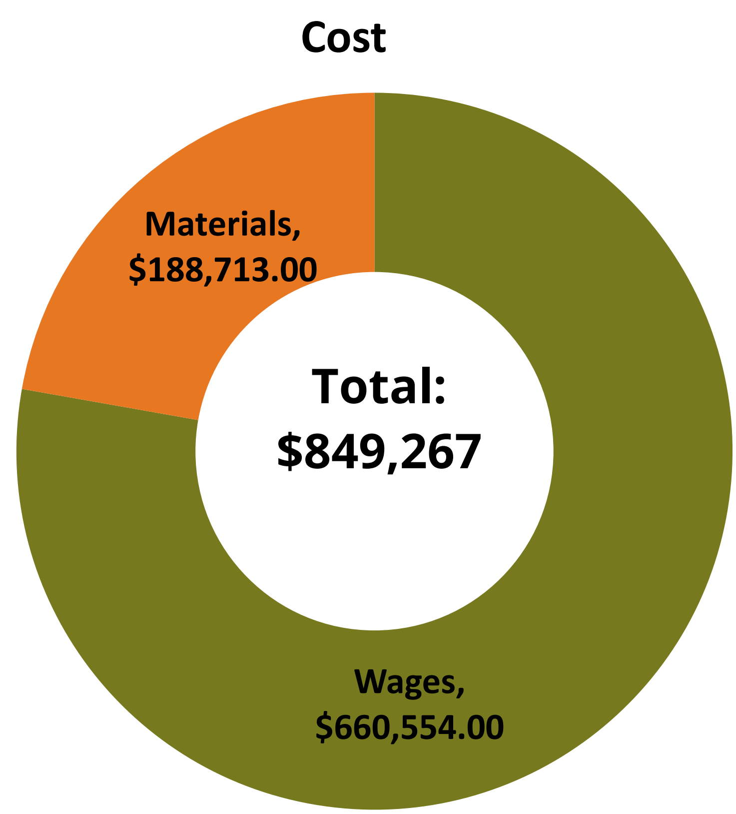



**Figure 5.**Total cost of trail issue repairs broken down by wage and materials cost if all applicable work was performed by park staff.

## *How has our trail system gotten to this point of disrepair?*

There are a variety of culprits that have caused the Tennessee State Parks' trail system to arrive at the condition that it is in today. Not only were many of the trails built in a manner that was unsustainable to the natural elements, but they were also unprepared for the sheer amount of visitation that they would receive after their construction. Last year alone Tennessee State Parks welcomed 34 million visitors. Even if only half of those visitors used our trail system that would still equate to 17 million hikers, or 34 million feet wearing down our trails annually. Even the most well-built trails will show wear after that amount of use.

Another factor that undoubtedly influenced the poor wear of our trails has been budgetary limitations. When money is tight, maintenance budgets and the staffs that support them are often the first things to be cut. Obviously with limited staffing or money to fix trail issues, they are allowed to continue to worsen. Unfortunately many solutions to trail problems that have been used in the past are just "Band-Aid", or short term, solutions. These things are meant to help in a pinch, but when left for extended periods of time can exaggerate existing issues. However, in the past these were the only things available to park staffs so they were often the "go-to" when trail issues arose.

Lastly, a major problem for our system has been a lack of sustainable trails education opportunities. As stated earlier, sustainable trails building is still somewhat a relatively new way of thinking when compared to the age of many of our trails. IMBA, seen as the leader in sustainable trail building education, was not formed until 1988. Even the National Park System did not have a definition for what it considered a sustainable trail until 1991.[5] Many times staff members can be overwhelmed with major trail maintenance problems and don't always know the correct solution, or have the means to perform them. This limited knowledge can also cause problems when expanding our trail system. Historically, parks have built new trails before evaluating whether or not they have the ability to maintain the trails that already exist. This over-extension of a park can cause issues down the road when the amount of trail maintenance increases while staffing does not.

5. IMBA, Trail Solutions: IMBA's Guide to Building Sweet Singletrack (Boulder: International Mountain Bicycling Association, 2004), 13

## *Final Thoughts*

As this was our first state wide trail assessment for Tennessee State Parks there were plenty of bumps and snags along the way, regardless of the tireless amount of work that our Park Ranger staff contributed. However, a lot was learned about the condition of our recreational trails. Though it was a long a tenuous process, it was recognized as a necessity due to the emphasis and impact that our park visitors put on hiking trails in our parks. With this new found data we will be able to more effectively direct efforts for trail maintenance on macro and micro levels.

This new data will also shape the way that trail maintenance is done. It shows that over the past decades the common approach of easy short term fixes simply does not help and that they often make our problems worse in time. In addition, managing this maintenance with only park staff may not be a viable option as history has shown. With each park ranger being responsible for an average 195 hours of trail maintenance it seems that an increase of trail specific employees may be needed to effectively tackle the issues at hand.

As our mission statement outlines, it is our job, "To preserve and protect, in perpetuity, unique examples of natural, cultural, and scenic areas and provide a variety of safe, quality, outdoor experiences through a well-planned and professionally managed system of state parks." Almost every part of that mission statement applies to our state wide trail system. Without proper, well thought out, and sustainable management our trails will not offer the safe and quality outdoor experience that they should and that our visitors expect. Nor will they align with our values to preserve and protect our natural, cultural, and scenic areas as bad trails are bad for the environment. However, with this data we will be able to do all of that and more with extensive precision and accuracy.

As a part of this report, an interactive online web application has been produced in order to aid in planning and productivity. A user's document for the web application has been included as Attachment C. Please find the web application by going to the following URL:

https://bit.ly/2L8rGyQ

Pogue Creek Canyon State Natural Area, 2017

# Attachment A

# Annual Trail Assessment Procedure Information

October 2016

This document will serve as the standards of procedure when conducting official trail assessments relating to the Annual Trail Assessment (ATA) in Tennessee State Parks. The purpose of the ATA is to obtain standardized data for all trails in the state parks; therefore, it is extremely important to maintain data integrity and objectivism when collecting trail information and measurements. It is recognized that in some situations this guide will not fit exactly, and in those cases it is requested that the assessors use their best judgement. However, if the assessors are still unsure of the correct protocol in a situation they are asked to contact their cell team leader or the Trails & Vista Administrator, Michael Meister.

## General Assessment Guidelines

- All data will be collected in imperial values (Inches, Feet, Miles)
- All data will be collected electronically using the Survey 1,2,3 mobile app
    - This may only be changed with exceptions cleared through the Trails & Vista Admin.
        - If there is technology trouble on site the day of assessment, paper may be used to record measurements
- All trail assessment equipment will be held by the Assessment Cell Team Leader when not in use
- All trail assessment equipment is expected to remain in its bag when not in use
- Trail assessment equipment will ONLY be used when performing official ATA assessments
- Trail assessment phases must be completed in order

## Equipment Bag Contents

- 2 Foot Smart Level
- 33 Foot Tape measure
- Clinometer
- Wilderness First Aid Kit
- ATA Protocol Manual
    - Field Data Sheets
- GPS Unit
    - Extra Batteries

# Phase I

Phase I exclusively assesses Trailheads and their components. This phase must be completed before beginning other phases.

**Measurements to be taken are:**

- Park Name
  - Select the park name from the drop down menu
- Trail Name
  - This should be selected from a drop down menu as well. If the trail name is not found in the drop down menu, then select "other" and fill in the trail name in the blank below.
  - If there is more than one trail starting at the trailhead, list the first one alphabetically.
- Trailhead Parking
  - If there is parking, measure the parking area. Length x Width (Estimates)
  - List its majority surface material
- Trailhead kiosk
  - If there is a kiosk:
    - Is there an accurate trail map included?
    - What is the overall condition of the kiosk?
      - Good, Fair, Poor
        - Look for things like a leaking roof, faded images, cracked posts, etc.
    - Take a photo of kiosk with Survey 1,2,3
- Visitor Safety Threat
  - Is there a safety situation that needs immediate attention?
- Make note of any facilities issues in the vicinity that need attention in the "Additional Comments" section
  - Damaged trashcans, benches, bicycle racks, etc. ANY piece of hardware that is owned by the state

# Phase II

Phase II exclusively assesses trail bridges and their components.

**Measurements to be taken are:**

- Park Name
  - Select the park name from the drop down menu
- Trail Name
  - This should be selected from a drop down menu as well. If the trail name is not found in the drop down menu, then select "other" and fill in the trail name in the blank below
- Bridge Tread Material
  - Selected from a dropdown menu
  - This should be the part of the bridge that your feet contact
- Bridge Construction Material
  - Selected from a dropdown menu
  - This should be what anchors the bridge to the ground
- Bridge Crossing
  - Dry, Wet
    - Wet crossings are classified as those that are wet for the majority of the year. Use your best judgement.
- Bridge Width
  - Measured from either side of the walking surface at the ground level.
- Bridge Length
  - Measured from where the bridge contacts the ground on either side.
- Bridge Height From Crossing
  - Measured from the top of the bridge tread to the lowest point on the ground.
  - If it is longer than the tape measure enter 33+
- Bridge Cross Slope
  - Slope of the bridge tread from right to left.
- Bridge Grade
  - The degrees of slope as you are walking along the bridge. It extends forwards and backwards. (Sometimes called the "running slope")

- Bridge Handrails

   - Yes, No
     - If yes, what is their height in inches?
- Bridge Type
   - Suspension, Fixed

- Bridge Condition
   - Good, Fair, Poor, Emergency Closure
     - We are only looking for observable conditions on the bridge. If things are noticeably wearing, missing, and failing then take that into account when rating a bridge.
     - If a bridge is to be closed immediately, the park manager is to be notified as well as the trail administrator.
- Bridge Problem
   - If there is a problem:
     - Describe what it is. (Sinking, cracking, leaning, etc.)
     - Take a photo of issue with Survey 1,2,3
- Visitor Safety Threat
   - Is there a safety situation that needs immediate attention?

# Phase III

Phase III exclusively assesses the trails themselves. This will be the most important, yet most difficult, part of the ATA. It will be less straight forward and will rely more on decision making in the field by the assessors.

Trail Assessment measurements will be taken at Problem Areas as defined by this manual and in your assessment course, as well as at all trail signage.

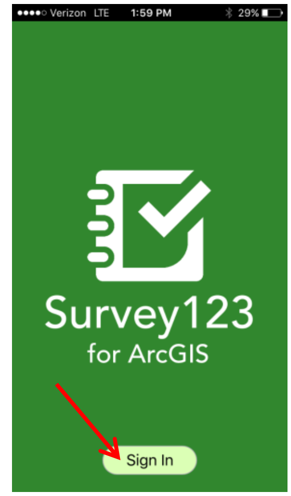
**Measurements to be taken are:**

- Park Name
  - Select the park name from the drop down menu
- Trail Name
  - This should be selected from a drop down menu as well. If the trail name is not found in the drop down menu, then select "other" and fill in the trail name in the blank below
- Blaze Color
  - Use best judgement, communicate with park staff if in question
  - If no blaze color, leave blank
- Trail Surface
  - Some trail surfaces will be mixed. If that is the case use your best judgement to choose the material that makes up the majority of the trail.
- Trail Width
  - This is the walking path width. The area of ground that receives the majority of foot traffic. (Usually starts and ends where there is a significant lack of vegetation)
- Trail Corridor Width
  - Width at shoulder height. (This includes over hanging vines and tree branches mostly and can extend past the actual trail width)
- Tread Depth
  - Depth of the deepest part of the trail as compared to the edges of the trail.
- Grade
  - The percentage of slope as you are walking along the trail. It extends forwards and backwards. (Sometimes called the "running slope")

- Cross Slope
    - The slope of the trail from side to side.
- Trail Problem
    - If there is a problem:
        - Select main cause of the problem
            - Berming/Cross Slope
            - Fall Line
            - Average 10% Grade
            - Half/50% Rule
        - Describe the problem with as much descriptive detail as possible
        - Take a photo of the problem with Survey 1,2,3
- Signage
    - What type of signage is it?
        - Interpretive
        - Directional
    - Condition of Signage
        - Good
        - Fair
            - This does not only cover wear and tear, but also that the information may be becoming less accurate or outdated.
        - Poor
            - Not only does this cover old and broken/damaged, but also inaccurate or illegible.
            - Photo of Signage

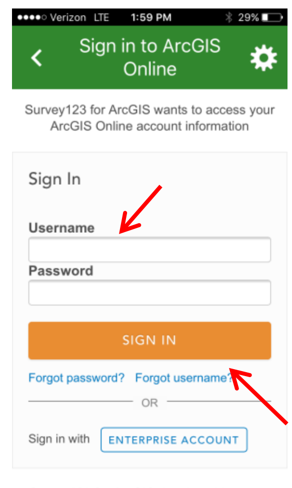
# Survey 1, 2, 3 User Guide

## Step 1:



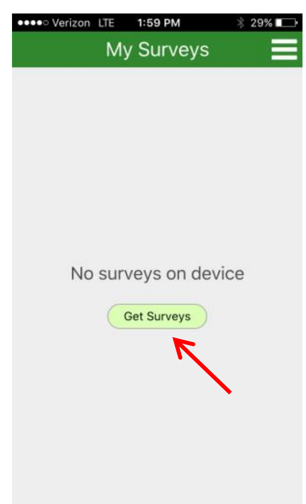

- Download “Survey 1, 2, 3” from the App Store
- Select the app from your home page.
- Once the app opens and you see this screen, select “**Sign In**”

## Step 2:



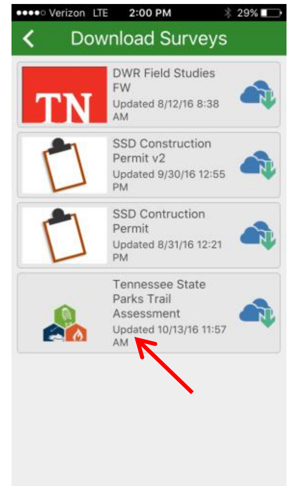

- At the login screen enter your ESRI username/password
  - **Username:** ______________________
  - **Password:** ______________________
- Press “**Sign In**” after you have entered the correct information

## Step 3:



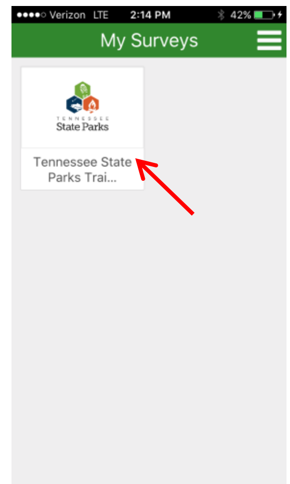

- Once logged in it will bring you to the “My Surveys” screen. From here you need to select the “**Get Surveys**” button.

## Step 4:



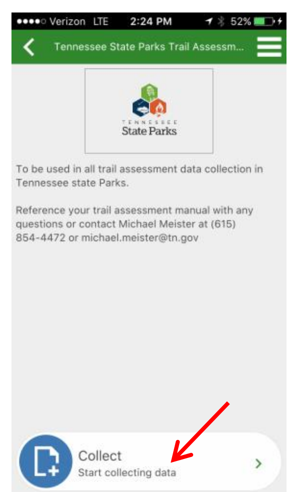

- Now from the "Download Surveys" screen you will see all surveys that are available for download.
- Select "**Tennessee State Parks Trail Assessment**" from the list of available surveys.
- This survey should now show up under your "My Surveys" screen

(**Note**: You must have cellular service or wifi to download the surveys for the first time, so it is often the safest practice to download the survey before getting to the site.)



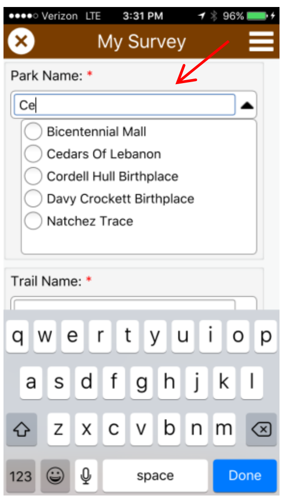

## Step 5:

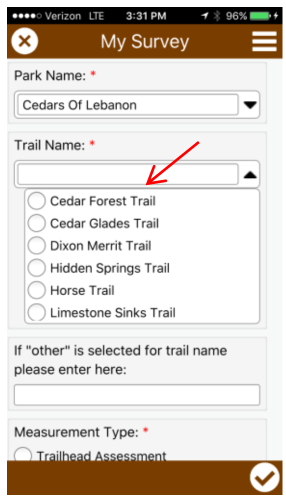
- Once you select the survey from the "My Surveys" screen you will be taken to that surveys home page
- This give you the option to collect new data or to view/edit/send data that you have already recorded.
- Select "Collect" to begin taking data.

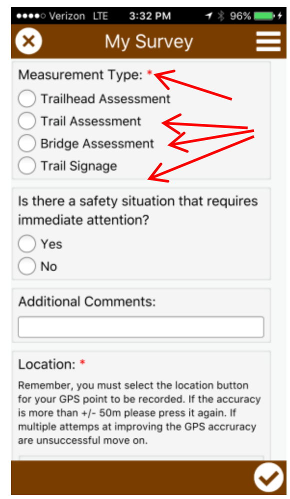


## Step 6:

- Once the survey opens select the correct park under “**Park Name**” that you are assessing.
    - Select from the drop-down menu or begin typing the park name
- Once the park is selected you will be able to select the correct trail under “**Trail Name**”.
    - Select from the drop-down menu or begin typing the trail name
- After selecting the correct park and trail chose your “**Measurement Type**” and respond to each field accordingly.

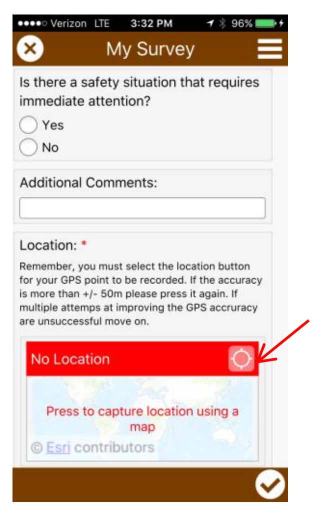


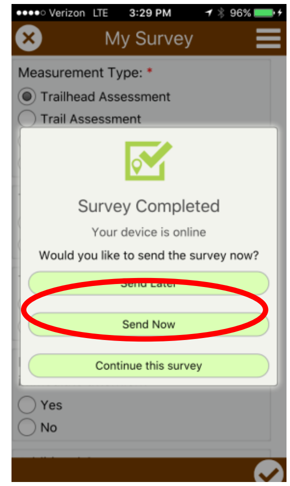




## Step 7:

- Before submitting your data you must make sure it is associated with a GPS location.
- To do this, click the location button (Crosshairs).
    - After your location is detected, it will be displayed above the map. We always want our data point to have the most accuracy possible, so pay close attention to the +/- number.
        - If your accuracy is higher than +/- 7m click the button again until it is less than 50m. However, if after multiple failed attempts it is acceptable to move on.



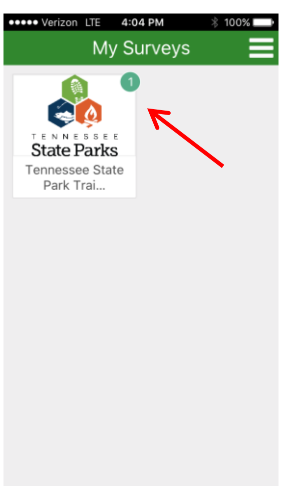
## Step 8:

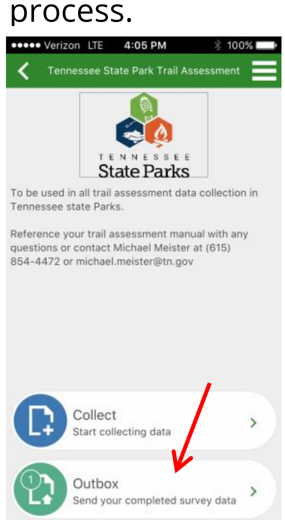


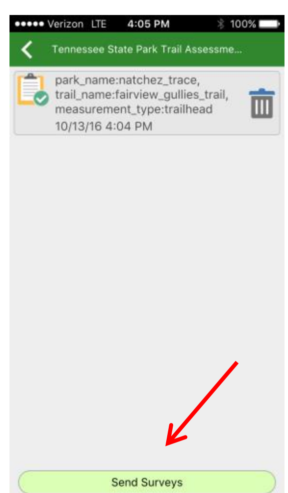

- After completing your survey entry click the check mark in the bottom right hand corner of your screen.
- You will then see a window with the option of "Send Later", "Send Now", and "Continue this Survey". When in the field always select "**Send Later**".
    - This will help conserve battery life and will ensure integrity of your data.

## Step 9:

- When you are finished collecting data and have returned to an area with good reception or wifi it will be time to upload your data to the trail assessment database.
- Click the back arrow until you arrive at your home screen.
- Surveys with data that needs to be sent will be marked by a small circle in the top corner with the number of data entries waiting.
- Once you select the survey it will show you the "Outbox" of data. Select your "**Outbox**".
- In your outbox you will see all of the data for that survey that is waiting to be sent to the database. At the bottom of the screen select "**Send Surveys**" to finalize the data collection process.



# Equipment Use

If any of these tools are damaged, lost, or used up (medical supplies), please notify the Trail Administrator so that any issued can be resolved.

## Survey 1,2,3 App:

- The app should be used in accordance with the use guide above. However, at times if the wrong “measurement type” is selected and then changed the app may act buggy and either not bring up the correct data inputs or it may leave some input fields from the measurement type that was selected at first. If this happens it is best to **close** the current survey, **do not save** the data, and **restart** that survey point. The app is still quite new, so unfortunately there is no other known way around this issue.

## Stabila/Smart Tool 24 Inch Digital Smart Level:

- The level will be used to record:
    - Grade
    - Cross Slope
- When taking measurements, set the level on the surface to be measured and give it a moment to normalize. The level’s digital read out is live so it can be held and adjusted as needed, however if you can keep your hand off of it while taking a measurement that would be best.
- If you are under the impression that the level is out of calibration (crazy numbers, different readings, etc.) refer to the user’s manual inside of your backpack to recalibrate it. Recalibration will also be taught in your assessment workshop.
- Though the level is tough, dustproof, and waterproof do your best to treat it like the breakable electronic that it is. It costs **HUNDREDS of dollars**, so please when not in use **keep it in its case** and try to keep it as dry and dirt free as possible.

## 33 Foot Tape Measure

- Tape Measure will be used to record:
    - Trail/Bridge Widths
    - Bridge Lengths

## Clinometer

- It may be small, but it is also a very expensive piece of equipment.
- Will be used to determine whether or not a section of trail is breaking the "half rule"
    - The half rule is when the grade, or the forward/backward running slope, is greater than 50% of the slope of the fall line grade in the area in which the trail is being built.
- Will also be used to determine the average grade of a trail section.
- Always go by **PERCENTS,** not degrees

## Medical Kit

- This medical kit is for security purposes while assessing trails because of the inherent risk of back country hiking. If it is needed in any way **PLEASE USE IT**, its supplies can be replaced. It is asked that you please only take it on hiking trips for assessment purposes, though, and use its supplies appropriately. Inside the medical kit you will also find a CAT tourniquet, please keep up with this item and do not take it out of the pack. All these items will be accounted for, so please if you need to use an item from the medical kit, do so, but notify the trail administrator so that it can be replaced in a timely fashion.

## Backpack

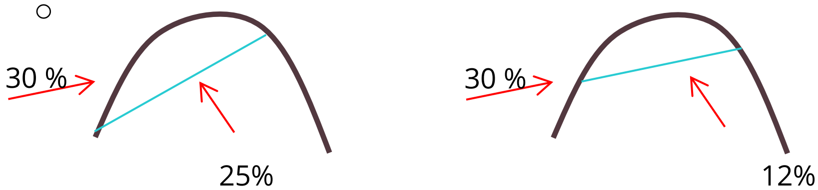
- The backpack that the assessment equipment is kept in should only be used for the storage of the equipment and the belongings/food/water of the people currently assessing. All assessors are encouraged to take ample supplies of food and water, but please take precautions to make sure that it does not leak into the backpack.

# Trail Problems

There can be a variety of problems on trails, and they can be caused by a large number of factors. This section will describe common problems on trails and their causes.

## Half Rule, 50% Rule

- This rule specifically addresses the grade of a trail in comparison to the grade of the landscape that it is on. The rule is stated as such that a **trail's grade should be less than 50%, or half, of the grade of the landscape that it crosses.**
    - Example: if the grade of a hill 30%, then any trail on that hillside should never have more than a 15% grade.




**Breaking Half Rule** Not Breaking Half Rule

## Fall Line Trails

- Fall Line Trails are closely related to the half rule. All fall line trails are breaking the half rule, but not all trails that break the half rule are fall line trails. The fall line is the direction down a slope that offers the steepest angle, and thus where all the water will naturally want to flow. Fall line trails are often the shortest route down a slope and therefore were made into trails for ease of construction.

## Outslope for Cross Slope

- The tread (walking surface) of a trail will almost always have a cross slope one way or another. For a sustainable trail, that cross slope should be going outwards and down the slope of the landscape. The optimal outslope is between 3-5%, though in some situations up to 8% is acceptable. Though 3-5% doesn't seem like much, it can make a world of difference when sheeting water off of a trail. But, too much cross slope can quickly make walking treacherous for users, so it is always best to stay as close to 3% as possible.

## Berming

- This is very closely related to a trails outslope. Berming can occur when organic material collects along the outer edge of a trail and prevents water from running off of it. Instead the water hits this berm and runs down the length of the trail. This can be very common on hillsides and around turns from user generated impacts.

## Cut-Throughs

- Cut-throughs are common problems in many Tennessee State Park Trail systems. The main reason is poor trail layout and design. If a trail doesn't flow well as the user is walking along it, then they are more likely to choose their own path, usually the one of least resistance. This can happen when trails wind around thinly spaced trees, or when turns are too close to each other.

## Tread Creep

- Tread creep is similar to cut-throughs as it is a trail problem caused by trail design, but comes from user impact. When a trail's outslope or inslope is too great, it can cause the users to only walk to one side of the trail causing the trail to slowly widen over time. This tread creep can be very detrimental to your trail edge as well as the habitat that your trail is travelling through. Tread creep can also be caused by obstacles in the trail such as large rocks or roots. People are more likely to go around obstacles than they are to step over them, once again causing the original path of travel to move.

# Attachment B

# Programmatic Analysis of Trails Assessment Data

## Assigning a solution to each Trail Interval data Point

The trails assessment survey included drop-down options for four types of rule violations under the *Trail Interval* measurement type: *Fall Line*, *Half Rule*, *Average 10%* and *Cross Slope/Berming*. Each of these four issue types was assigned an arbitrary value, which was used to populate a new data field called *"Problem Cause Value."*

| *Fall Line* | *Half Rule* | *Average 10%* | *Cross Slope/Berming* | *Other* |
|---|---|---|---|---|
| 17 | 15 | 13 | 11 | 9 |

*Table 1: Problem cause values assigned to issue types based on rule violation.*

Flagged issues in each issue type vary in severity. To quantitatively assess an issue's severity, the *grade measurements* and *cross slope measurements* recorded by field staff were examined and classified. Grade measurements were used to assess the severity of Fall Line, Half Rule, and Average 10% rule violations, while cross slope measurements were used in assessing Cross Slope/Berming issues.

However, for many flagged issues, grade and cross slope measurements were not provided. In these instances, severity was assessed qualitatively through the classification of keywords found in the description and comments fields. The table below details the keywords and measurement values corresponding to each of four severity classes, or weighted values.

This weighted value was entered into a new field called *"Keyword Value."* Keyword values were assigned first using quantitative methods. Qualitative methods were used to populate the Keyword Value field only where a value was not already established from the measurements.

| **Qualitative** | **Quantitative** | | |
|---|---|---|---|
| *Keywords pulled from "Problem description field* | *Grade* | *Cross slope* | *Weight* |
| Start, Begin, Minor, Small, 20, 25, 30, blaze, blazing, future, moist, moisture, seasonal, sign, signage, wet, widening | <10 | <8 | 2 |
| Trench, Ditch, Gully, 35, 40, 50, collect, de berm, deberm, de-berm, down hill, downhill, drain, drainage, draining, erosion, hold, holds, in slope, inslope, in-slope, narrow, run, run off, running, runoff, slick, slippery, soggy, volume, wash, washing | 11-17 | 9-12 | 4 |
| Long, Bad, Deep, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, channel, channelize, cross slope, crossslope, cross-slope, deep, ditch, eroded, excessive, funnel, heaby, huge, large, rut, rutted, rutting, steep, terrible, trench, trenching | 18-25 | 13-15 | 6 |
| Grade Dip, Major, Massive, Serious, Dangerous, Reroute, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165 ,170, 175, 180, 185, 190, 195, 200, 1/4, 1/2, 3/4, .25, .50, .75, quarter, half, three quarters, three-quarters, bog, extreme, flat, gully, hundred, majority, mud, muddy, mudhole, pool, pooling, poor, re route, re-route, standing, swamp, switch back, switchback, switch-back | >25 | >16 | 8 |

*Table 2: Keyword values corresponding to quantitative measurements and keywords pulled from qualitative problem descriptions.*

Keyword values, representing weight or severity of an issue, and problem values, representing the type of rule violation, were combined according to the following formula.

```
Solution Score = Problem Cause Value * Keyword Value
```

The result of this formula is a number unique to each particular combination of weight and rule violation. This value was entered into a new field called "*Solution Score*." With a potential solution to the trail problem corresponding to each solution score, we were ultimately able to programmatically assign a potential solution to each flagged trail interval issue.

*ON FOLLOWING PAGE*

*Table 3: Final matrix used in analysis, comparing problem types to keyword words and assigning possible solutions.*

# Assessment Severity Matrix

| KEYWORD VALUES | | | | ISSUE TYPES | | | | |
|---|---|---|---|---|---|---|---|---|
| DESCRIPTIONS | MEASUREMENTS | | | Fall Line | Half Rule | Average 10% | Cross Slope/Berm | Other |
| **Severity Keywords (From "Problem Description" field)** | **Grade Values (Fall Line, Half Rule and Average 10%)** | **Cross Slope Values (Cross Slope/Berm)** | **WEIGHT** | **17** | **15** | **13** | **11** | **9** |
| Start, Begin, Minor, Small, 20, 25, 30, blaze, blazing, future, moist, moisture, seasonal, sign, signage, wet, widening | <10 | <8 | **2** | Observation, Potential Rolling Grade Dip (**34**)<br><br>Hours = 1 | Observation, Potential Rolling Grade Dip (**30**)<br><br>Hours = 1 | Observation, Potential Rolling Grade Dip (26)<br><br>Hours = 1 | Easy De-Berming (**22**)<br><br>Hours = 3 | Add Blazing (**18**)<br><br>Hours = 3 |
| Trench, Ditch, Gully, 35, 40, 50, collect, de berm, deberm, de-berm, down hill, downhill, drain, drainage, draining, erosion, hold, holds, in slope, inslope, in-slope, narrow, run, run off, running, runoff, slick, slippery, soggy, volume, wash, washing | 11-17 | 9-12 | **4** | 1 Rolling Grade Dips (**68**)<br><br>Hours = 3 | 1 Rolling Grade Dips (**60**)<br><br>Hours = 3 | 1 Rolling Grade Dips (**52**)<br><br>Hours = 3 | Intermediate De-Berming (**44**)<br><br>Hours = 5 | Cut Out Root (**36**)<br><br>Hours = 4 |
| Long, Bad, Deep, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, channel, channelize, cross slope, crossslope, cross-slope, deep, ditch, eroded, excessive, funnel, heaby, huge, large, rut, rutted, rutting, steep, terrible, trench, trenching | 18-25 | 13-15 | **6** | Multple Rolling Grade Dips (**102**)<br><br>Hours = 16 | Multple Rolling Grade Dips (**90**)<br><br>Hours = 12 | Multple Rolling Grade Dips (**78**)<br><br>Hours = 10 | Difficult De-Berming (**66**)<br><br>Hours = 8 | Cut Out Stump (**54**) |
| Grade Dip, Major, Massive, Serious, Dangerous, Reroute, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165 ,170, 175, 180, 185, 190, 195, 200, 1/4, 1/2, 3/4, .25, .50, .75, quarter, half, three quarters, three-quarters, bog, extreme, flat, gully, hundred, majority, mud, muddy, mudhole, pool, pooling, poor, re route, re-route, standing, swamp, switch back, switchback, switch-back | >25 | >16 | **8** | Reroute (**136**)<br><br>Hours = 80 | Reroute (**120**)<br><br>Hours = 60 | Reroute (**104**)<br><br>Hours = 36 | Reroute (**88**)<br><br>Hours = 24 | Recut Tread (**72**) |

# Calculating relative severity of each Trail Interval problem

To determine a problem's relative severity, we looked to the "*Keyword Value*" field calculated above. The keyword value assigns to each data point a weighted score (2, 4, 6 or 8) based on the severity of a *grade* or *cross slope* measurement, or on keywords which indicate the seriousness of a trail problem.

A new field, "Severity Score," was calculated by halving the keyword value where it was given. Where a keyword value was not given, the severity score was calculated as *0*, under the assumption that no problem or issue exists.

The Trails Assessment survey included a Boolean field recording whether each data point was considered to be a safety issue. Where the *Safety* field was *True,* the severity score was calculated as 5. This value overrides any severity score previously assigned from a keyword value, so as to prioritize guest safety.

| **Severity Score** | **Description** | **How was it calculated?** | |
|---|---|---|---|
| 0 | No issue | *Keyword Values* | Any item not weighted via measurement or descriptive queries |
| 1 | Minor issue | | Any item weighted "2" (grade <10, cross slope <8, associated keywords) |
| 2 | Moderate issue | | Any item weighted "4" (grade 11-17, cross slope 9-12, associated keywords) |
| 3 | Intensive issue | | Any item weighted "6" (grade 18-25, cross slope 13-15, associated keywords) |
| 4 | Very intensive issue | | Any item weighted "8" (grade >25, cross slope >16, associated keywords) |
| 5 | Safety concern | *Safety Issue T/F* | Safety value of "True," overrides any value 0-4 assigned via keyword values |

*Table 4: Methodology for assigning severity scores.*

## Results and manual analysis

A total of 2759 data points were collected in the trails assessment survey. Of these, 1837, or two-thirds, correspond to the *Trail Interval* measurement type. Of these 1837 records, 1656 were programmatically assigned a solution score. The remaining 181 trail interval data points did not include either grade or cross slope measurements or keywords corresponding to a keyword value and therefore could not be analyzed according to these methods.

Of the 1656 points analyzed programmatically, 207 were not classified as violating one of the four rules; that is, these 207 points fell into the "Other" category as seen in Table 1. Upon initial review of the results, it quickly became clear that this methodology was ineffective at assigning meaningful or accurate solution scores to these 207 uncategorized problems, due to the wide variety of issues described therein.

Combining the uncategorized problems whose solution scores are not reliably accurate with the data points that were not assigned a score, we see a total of 388 Trail Interval data points that must be manually reviewed, manually assigned a potential solution, and/or manually assigned a severity score. We can say, then, that approximately 79% of Trail Interval records were meaningfully analyzed using this methodology.

This methodology was not able to assign values to measurement types other than Trail Interval. Trail Bridge and Trail Signage data points that are flagged as problems must be manually assigned potential solutions and severity scores. Of 462 Bridge measurements, 78 were flagged as problems, and of 238 Signage measurements, 26, for a total of 104 additional points in need of manual analysis. Because the trails assessment survey was not designed to record problems at Trailhead measurements, those 222 points have been ignored in this analysis.

| | *Total data points* | *Flagged as problem/issue* | *Score was calculated programmatically* | *Unable to calculate score* | *Score was calculated, but needs manual review* | ***Total Manual Analysis #*** | ***Total Manual Analysis %*** |
|---|---|---|---|---|---|---|---|
| *Bridge* | 462 | 78 | 0 | 78 | 0 | 78 | 16.88% |
| *Signage* | 238 | 26 | 0 | 26 | 0 | 26 | 10.92% |
| *Trailhead* | 222 | | | | | | |
| *Trail Interval* | 1837 | 1837 | 1656 | 181 | 207 | 388 | 21.12% |
| **TOTAL** | **2759** | **1941** | **1656** | **285** | **207** | **492** | **26.78%** |

# Attachment C


# Trails Assessment 2017-2018

## WebApp Documentation

***May 2018***

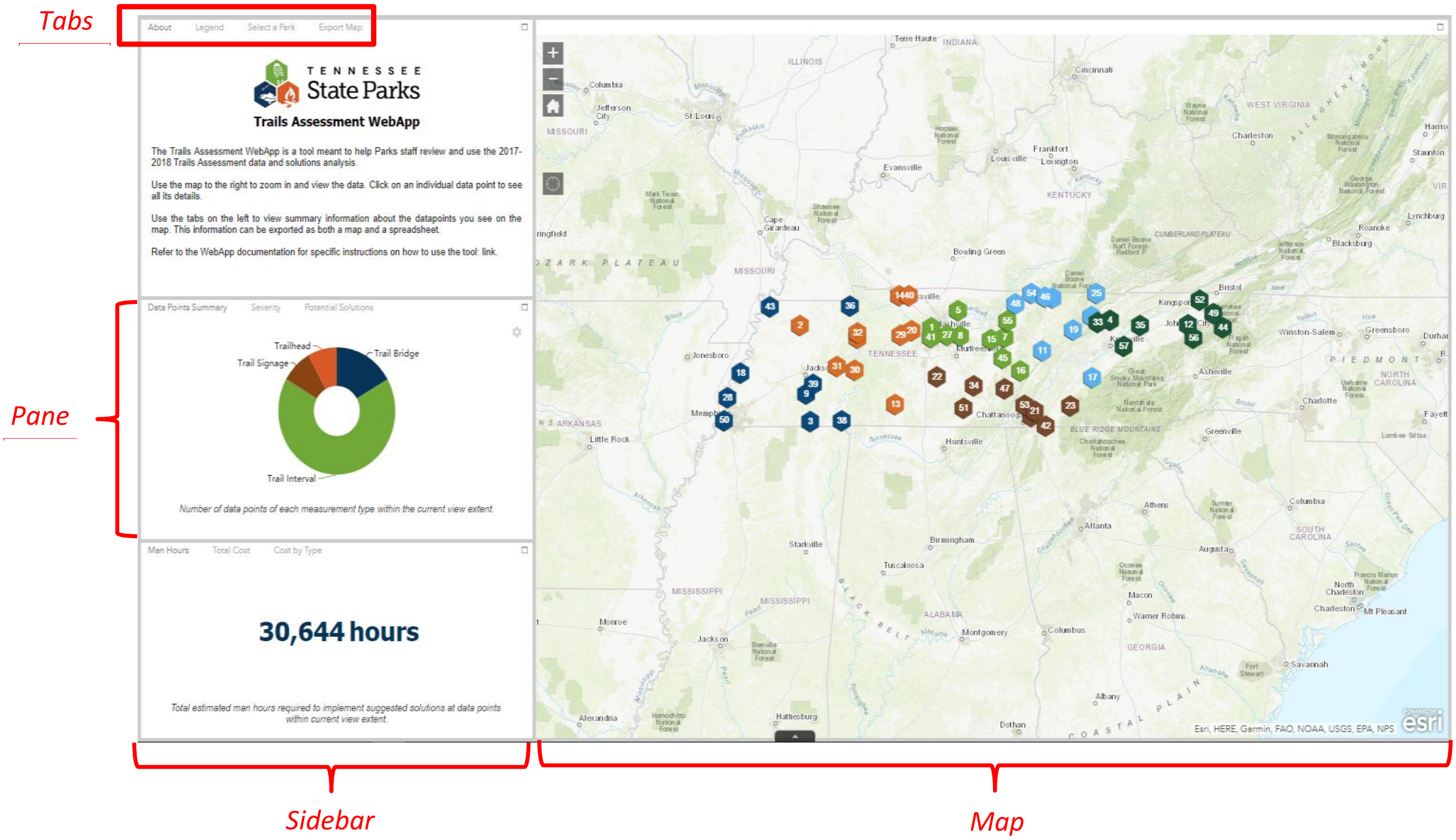
TENNESSEE State Parks

TN Department of Environment & Conservation

# Contents

# Overview

The **Trails Assessment WebApp** is a tool meant to help Parks staff explore the 2017-2018 Trails Assessment data and solutions analysis. The WebApp allows us to navigate an interactive map of the State Parks system and visualize the data in different ways. We can also export the data both in map format and in spreadsheet format.




When you first **open the WebApp**, you will see this screen. The screen is divided into two major parts: the *map*, on the right-hand side of the page, and the *sidebar*, on the left. The sidebar is divided into three different *panes*, each of which contains multiple *tabs*.

# Navigating the Map


In the top-left corner of the map, you will see four icons.

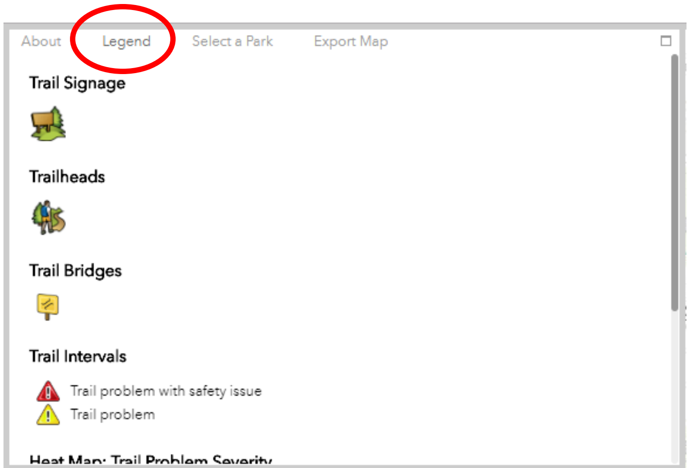
Use the *plus sign* and *minus sign* to zoom in and out of the map. You can also use the wheel of your mouse to zoom.

Use the *home* icon to return to the full extent of the map, viewing the entire state.

Click on the *location icon* to zoom in on the map to your current location on the ground.

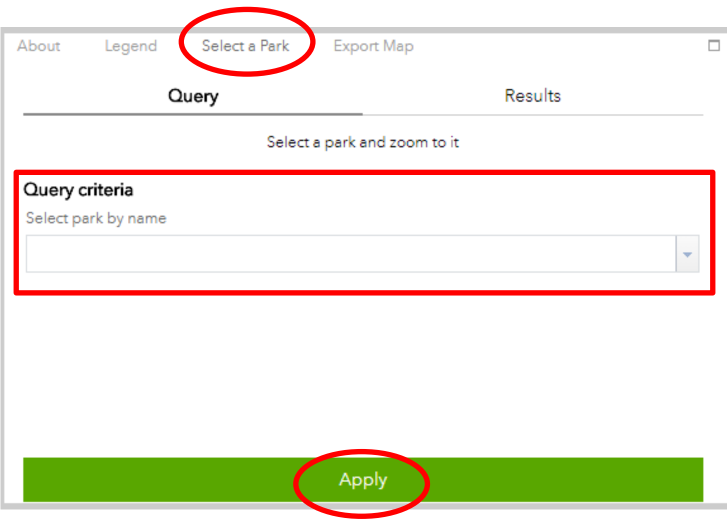
To pan around the map, click and hold the left mouse button while dragging your mouse in any direction. You can also use the arrow keys on your keyboard to pan.

## *Legend Tab*




The map legend can be found in the top pane of the sidebar. Click on the word "Legend" to pull up the legend tab. The legend will display only those items that are currently visible on your map. So, if you are zoomed out at the state level, you will not see all the map features in the legend.

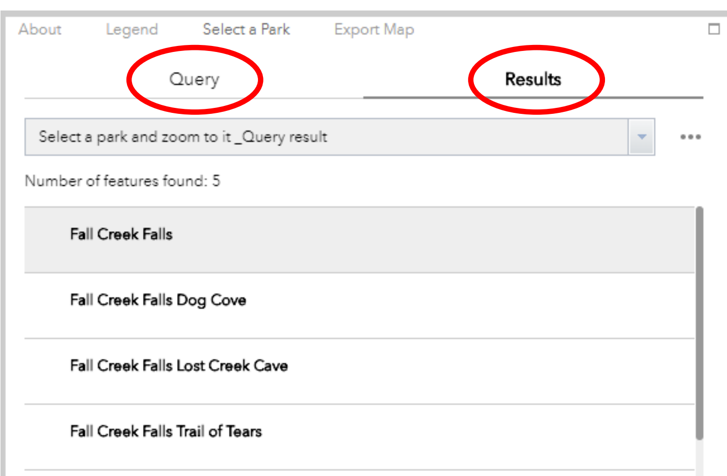
## *Select a Park Tab*




Click on the "Select a Park" tab in the top pane of the sidebar. Here, you can query or search for a particular park.

Use the drop-down menu under "Query criteria" to select a park. Then, click *Apply*.

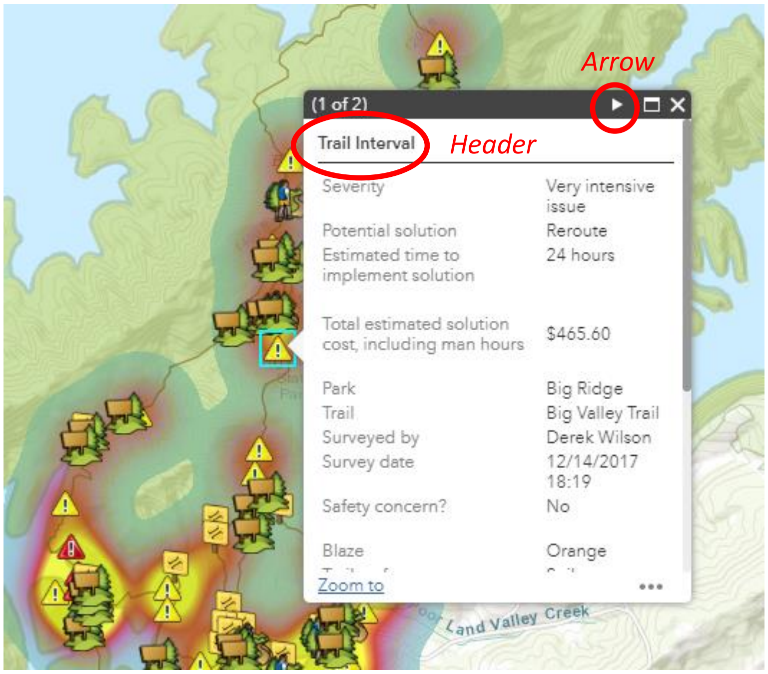
The map will automatically zoom in to the selected park.




If the park you chose has multiple satellite locations, you will see a list of satellites in the *Results* window. Click on one of these satellite names to zoom in further.

To search for another park, click *Query* to return to the search window.

### ***Pop-up Information***




Click on any individual datapoint on the map to bring up the pop-up information window. This window displays all details about each datapoint, including measurements and solution estimates.

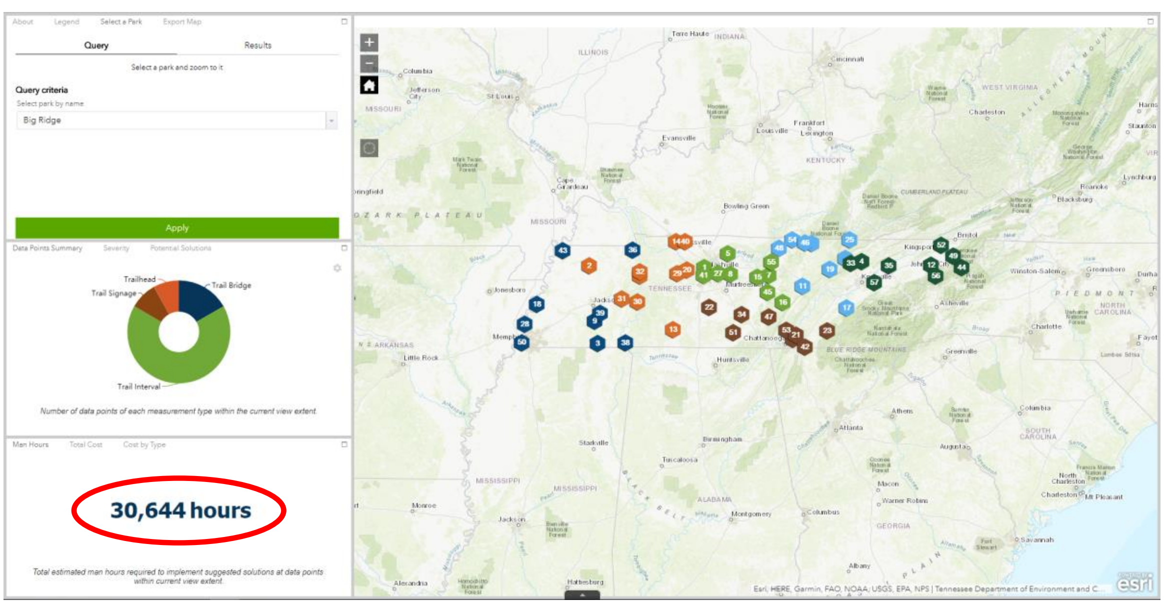
The pop-up window header will display the type of trail assessment measurement: trail interval, bridge, signage, or trailhead. The table of information in the pop-up window will change for each measurement type, so that you are only viewing the relevant information.

If multiple datapoints overlap, you can use the *arrow* on the right-hand side of the pop-up window header to scroll through each selected point. You can also zoom in closer on the map to help differentiate datapoints.

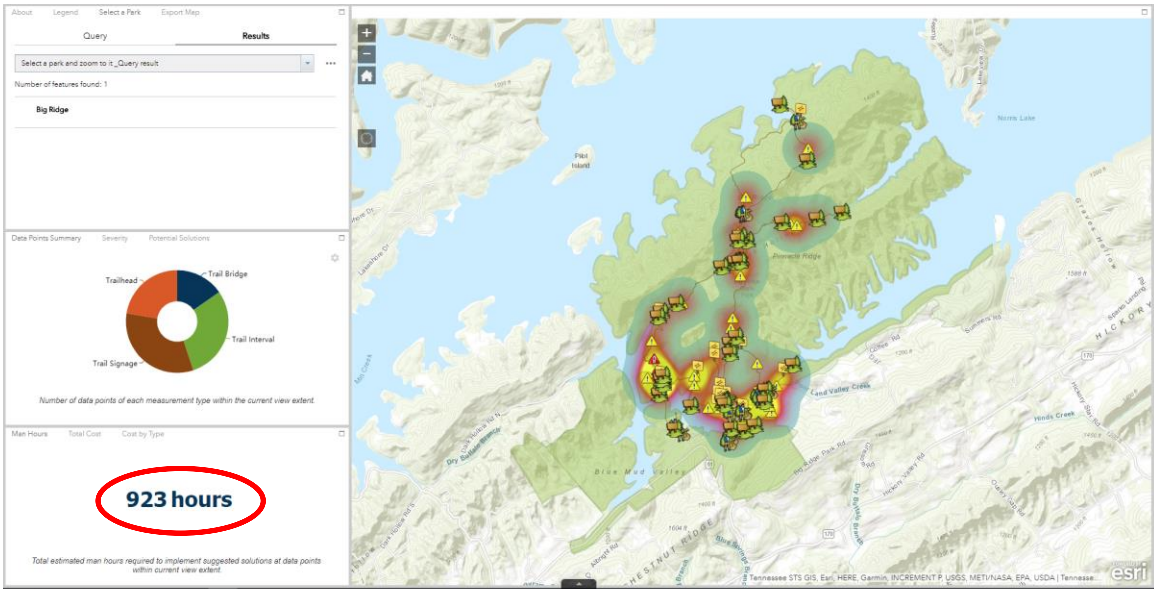
## Using the Sidebar Infographics

The middle and bottom panes of the sidebar contain several interactive infographics to help you visualize the trails assessment data. These infographics are dynamic and will change to reflect the view extent of the map.

Zoomed out to the state level, we can see the total number of estimated hours required to implement solutions to all trail problems: 30,644.

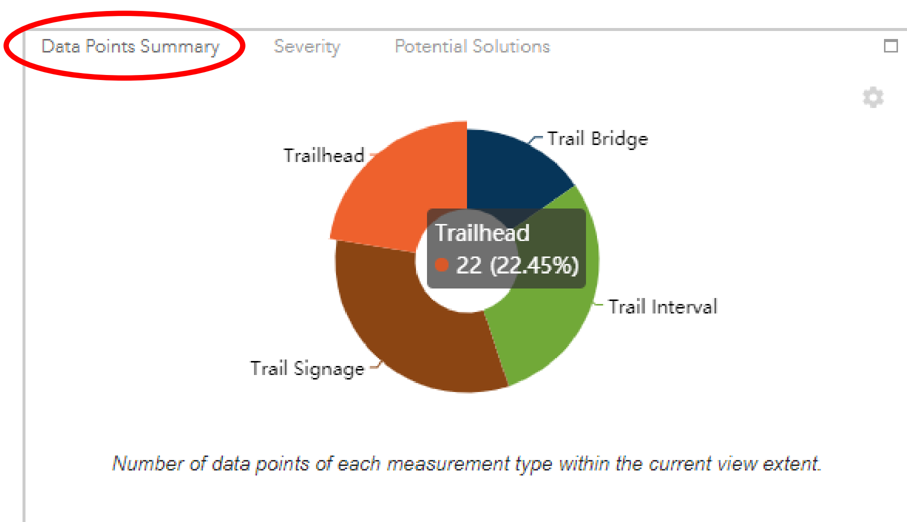


If we then use the “Select a Park” tab to zoom in on Big Ridge State Park, the infographics will changed. Now we can see the total number of estimated hours required to implement solutions to trail problems at Big Ridge only: a much smaller number, 923.




If we were to zoom in further so that just a portion of a park was visible on our map, the infographics would change again. The infographics are always based on *only the datapoints you can see* in the map.

### ***Data Points Summary Tab***

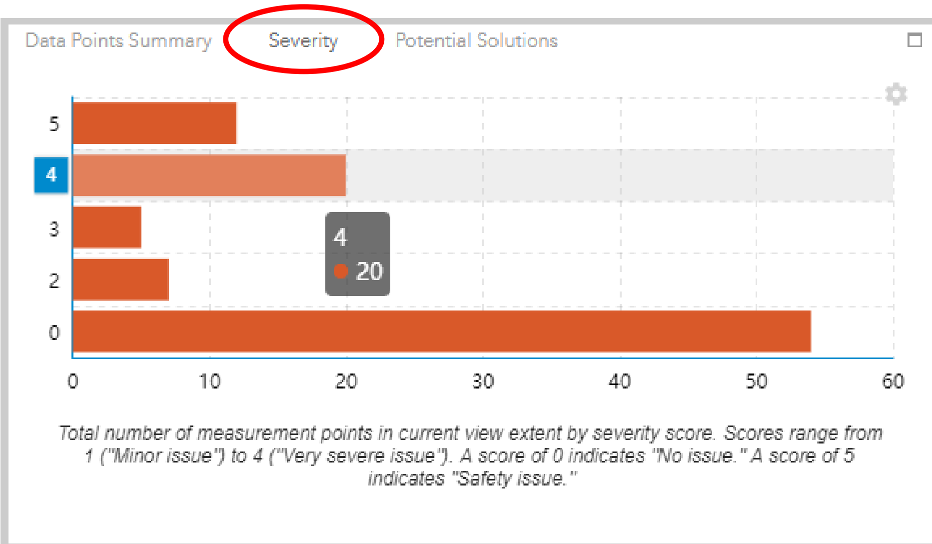



The “Data Points Summary” tab on the middle pane of the sidebar displays a breakdown of datapoints by measurement type.

As with all infographics, this chart is responsive and changes based on the current view extent. This information applies only to the datapoints you can currently see on the map.

Hover the cursor over each slice of the pie to see the number of points and the percentage of the total. In this example, there are 22 trailhead measurements displayed on the map, which makes up 22.45% of all datapoints.

### *Severity Tab*



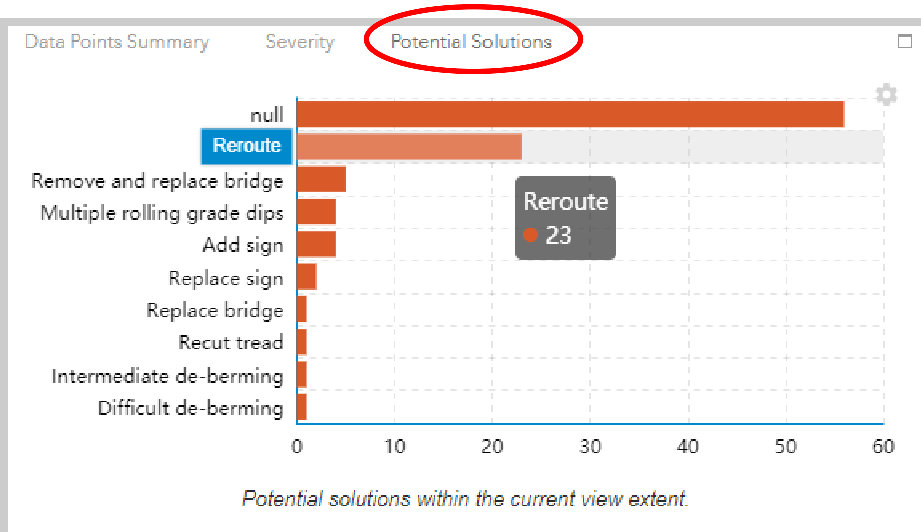

To the right of the "Data Points Summary" tab is the "Severity" tab. This chart shows you how many datapoints in the current view extent fall into each severity category.

The categories are:

**0** – No issue
**1** – Minor issue
**2** – Moderate issue
**3** – Intensive issue
**4** – Very intensive issue
**5** – Safety issue

Hover the cursor over each bar in the graph to see the number of points. In this example, there are 20 trails problems rated as "very intensive" issues displayed on the map.

### *Potential Solutions Tab*



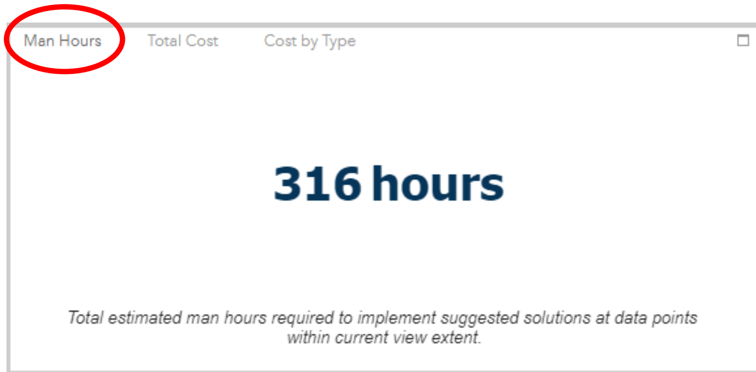

This graph displays all the potential solutions to issues seen in the current view extent, and gives us the number of data points for each solution.

Hover the cursor over each bar in the graph to see the number of points. In this example, there are 23 datapoints in need of a trail reroute displayed on the map.

A "null" solution indicates that no potential solution has been assigned to a datapoint. In most cases, this is because there was no issue associated with that point.

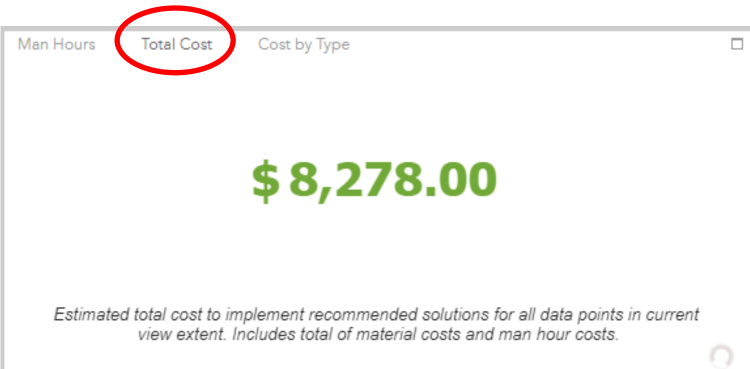
You can use the wheel on your mouse to zoom in and out of the graph. This may be helpful if you are zoomed out to a very wide area of the map, such that many different solutions are displayed on the graph.

### *Man Hours Tab*



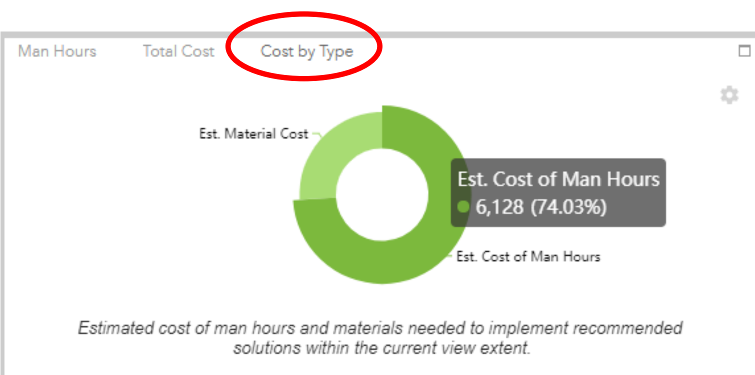

The “Man Hours” tab displays the total number of estimated hours required to implement the suggested solutions to all datapoints currently visible on the map.

### *Total Cost Tab*




The “Total Cost” tab displays the total estimated cost to implement suggested solutions to all datapoints currently visible on the map.

### *Cost by Type Tab*




The “Cost by Type” tab gives you a pie-chart breakdown of the total cost by material cost and labor cost for solutions in the current map extent. The labor cost is calculated by multiplying the total number of estimated man hours by $19.40.

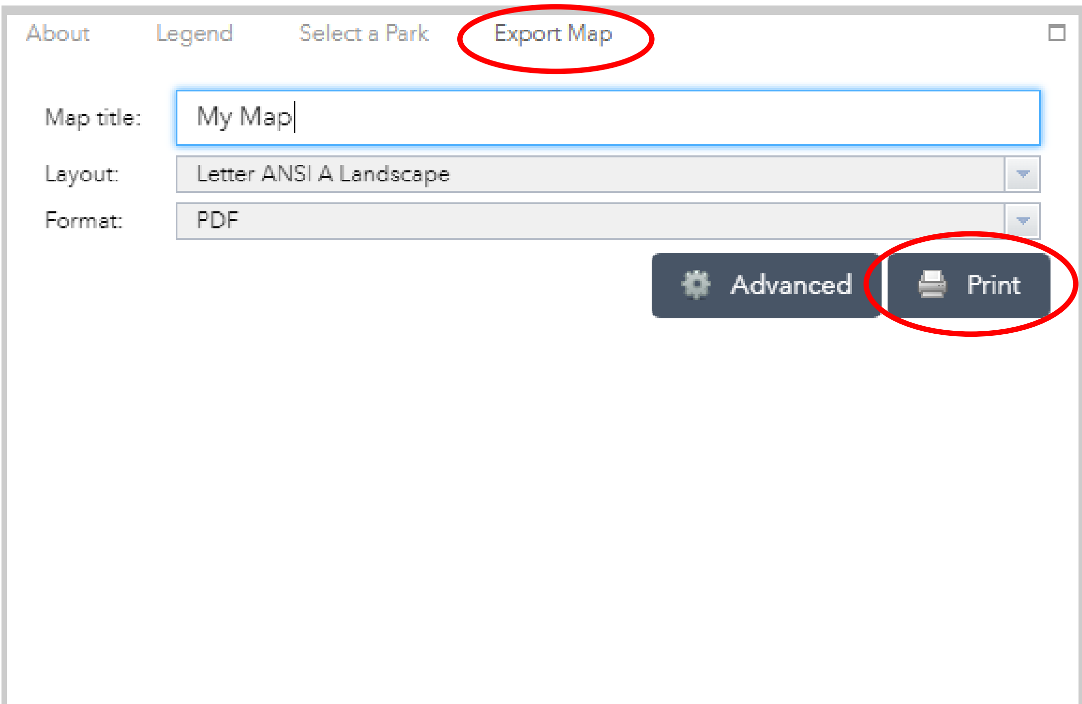
Hover the cursor over each slice of the pie to see the total dollar amount, as well as the percentage of the entire cost. In this example, the estimated cost of labor to implement all shown solutions is $6,128, or 74.03% of the total estimated cost.

# Exporting Data

You can export data from the WebApp in two different formats. First, you can create a snapshot map and save it as an image. Second, you can export all tabular information to a spreadsheet.

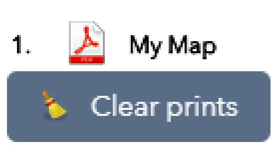
## *Export Map Tab*

The "Export Map" tab is the last tab on the right in the top pane of the sidebar. On this tab, you can enter a title for your map, choose a layout, and select an export format. The recommended settings are the "Letter ANSI A Landscape" layout, in order to fit the map on a regular sheet of paper, and the PDF format.




You can click on the *Advanced* button to set additional settings for the map, but this is not recommended.

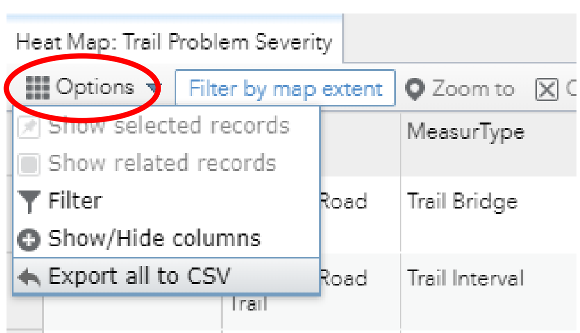
Once you have given your map a title and checked that the layout and format are correctly selected, press the *Print* button to make the map. The program will work for a few moments. When it's done, you should see a PDF icon appear with the name we gave your map. Click on this to open the PDF map.



### ***Export Spreadsheet with the Attribute Table***

Hidden at the very bottom center of the WebApp display is a button that opens the *Attribute Table*.


The attribute table is set by default to show only information about datapoints in the current view extent. If the *Filter by map extent* button is highlighted blue, then you will only see and export data within the map extent. If you want to export all trails assessment data, you have to click on the *Filter by map extent* button to toggle it off.


To export the attribute table to a spreadsheet, click on the *Options* button, then *Export all to CSV*.

The CSV file can then be opened in Microsoft Excel.

## Contact

For questions regarding the Trails Assessment program, including cost and solutions analysis, contact:

Michael Meister
Trails and Vistas Administrator
TDEC Division of Facilities and Land Management
(615) 854-4472
**michael.meister@tn.gov**

For help with using the WebApp, contact:

Rachel Schultz
GIS Specialist
TDEC Division of Facilities and Land Management
(615) 232-4276
**rachel.schultz@tn.gov**