

# Current Flow Whack-A-Mole

## Eliminating Primary Return Current Flows with the Nuisance Current Blocker

by Andrew M. McAfee

In a ... risk assessment conducted under the auspices of the National Institute of Environmental Health Sciences, an expert panel [NIEHS Working Group, 1998] concluded that at “internal electric field strengths greater than approximately 1 mV/m. . .numerous well-programmed studies have show strong effects on other endpoints commonly associated with carcinogenic agents. ...the electric field in bone marrow from as little as 1  $\mu$ A contact current exceeds this 1 mV/m benchmark. <sup>1</sup>

Research conducted ... has addressed the hypothesis that the reported association between residential magnetic fields and **childhood leukemia may be explained by exposure to contact current.**

[T]he model estimates that **10  $\mu$ A of current produces about 50 mV/m** averaged across the marrow in the lower arm of a small child, and about **130 mV/m or above in 5% of that tissue.**<sup>2</sup> ...[W]e anticipate that, for U.S. style electrical and plumbing systems, currents at levels of 10  $\mu$ A and above may occur in roughly 5 – 10% of residences.

"The EPRI states that **60 percent of primary current is expected to flow back over the earth**" through the grid's multi-grounded system. Furthermore, "testing has revealed [an even] higher percentage. In one case up to 81 percent of the primary distribution current was returning uncontrolled through the earth to the source substation."<sup>3</sup>

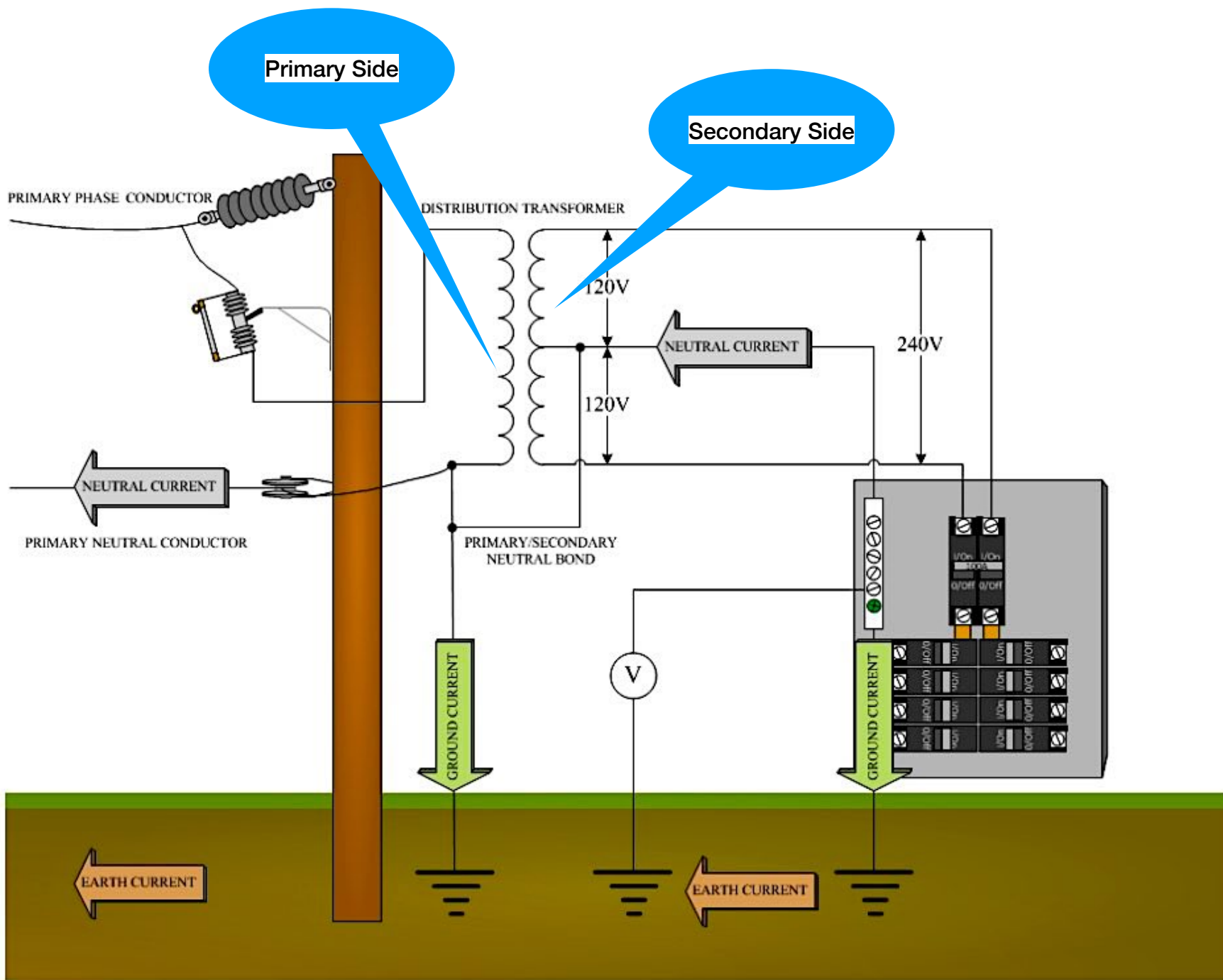
Therefore, it is imperative, in order to achieve a true health standard, we must remove the sources of current from the surfaces we make contact with in the home. One significant variable, that has been largely overlooked or ignored, is the contribution made by the primary return current flows through our grounding system.

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1 Contact Voltage Measured in Residences: Implications to the Association Between Magnetic Fields and Childhood Leukemia. Kavet and Zaffanella. Environment Department, EPRI. Bioelectromagnetics 23:464 ^ 474 (2002)

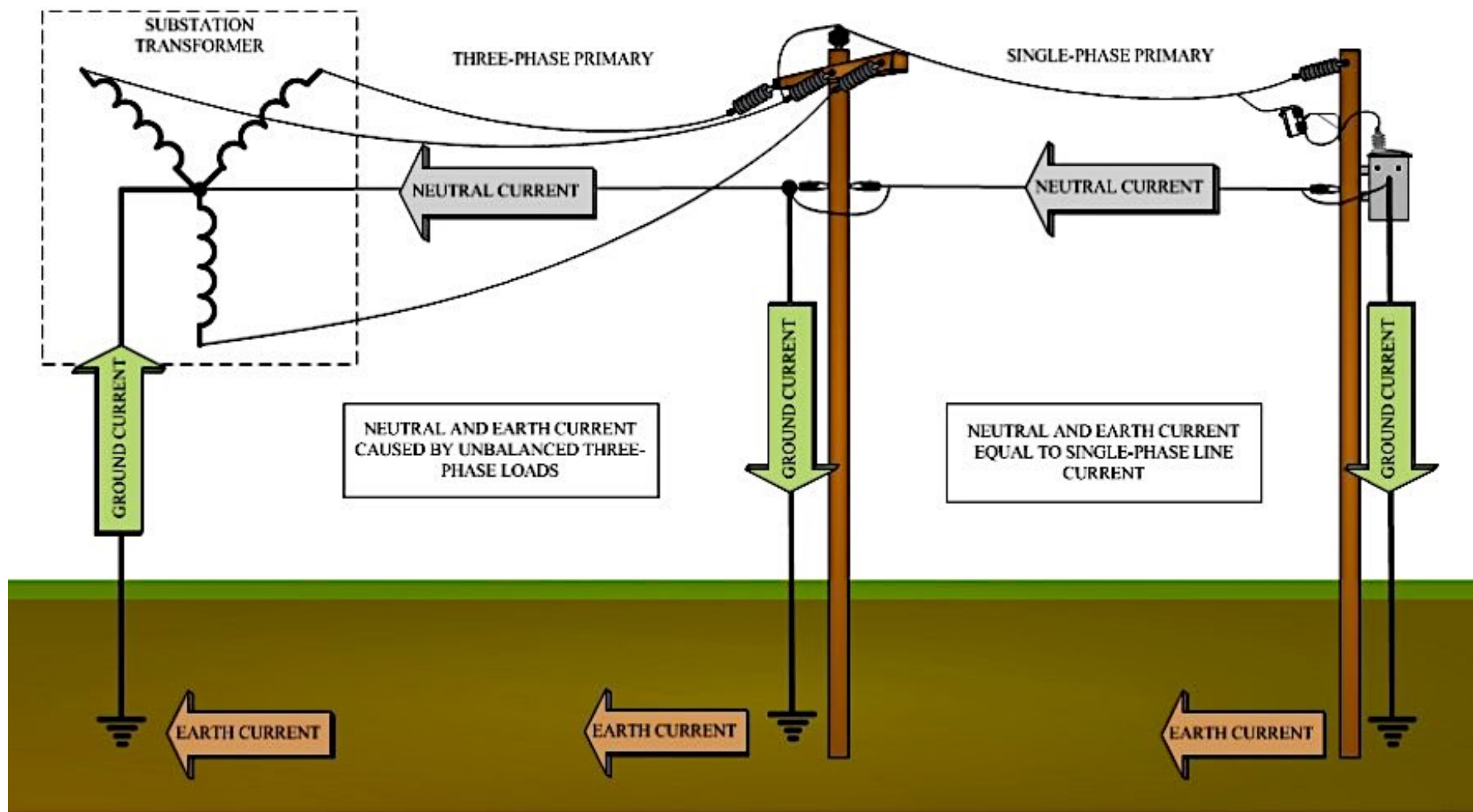
2 Contact Current Hypothesis: Summary of Results to Date. Robert Kavet. Electric Power Research Institute (EPRI), Bioelectromagnetics Supplement 7:S75 ^ S85 (2005)

3 Death by Grounding. W. Zipse, Donald. (2008). 1 - 11. 10.1109/PCICON.2008.466396. <http://donaldwzipse.com/images/PID642277.pdf>



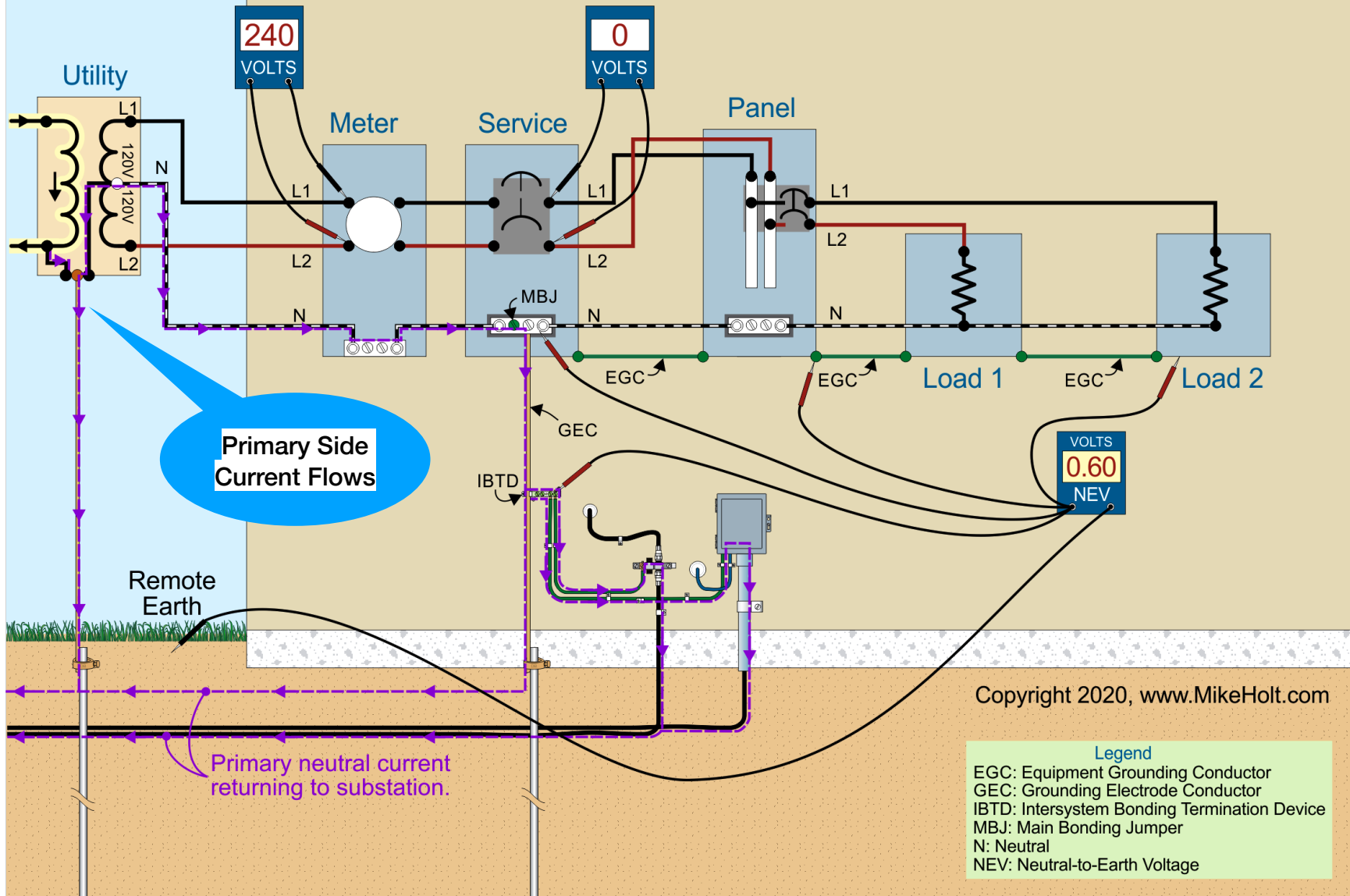
**Figure 17—Typical residence with secondary neutral bonded to primary neutral and earth**

IEEE Std 1695-2016  
IEEE Guide to Understanding, Diagnosing, and Mitigating Stray and Contact Voltage



**Figure 16—Normal neutral, ground and earth current paths in a multi-grounded Wye distribution system**

# Neutral-to-Earth Voltage (NEV) Main Breaker Open



Primary Side  
Current Flows

Service  
Neutral

Service  
Equipment

**GEC:**  
Grounding  
Electrode  
Conductor

**IBT:**  
Intersystem  
Bonding  
Termination

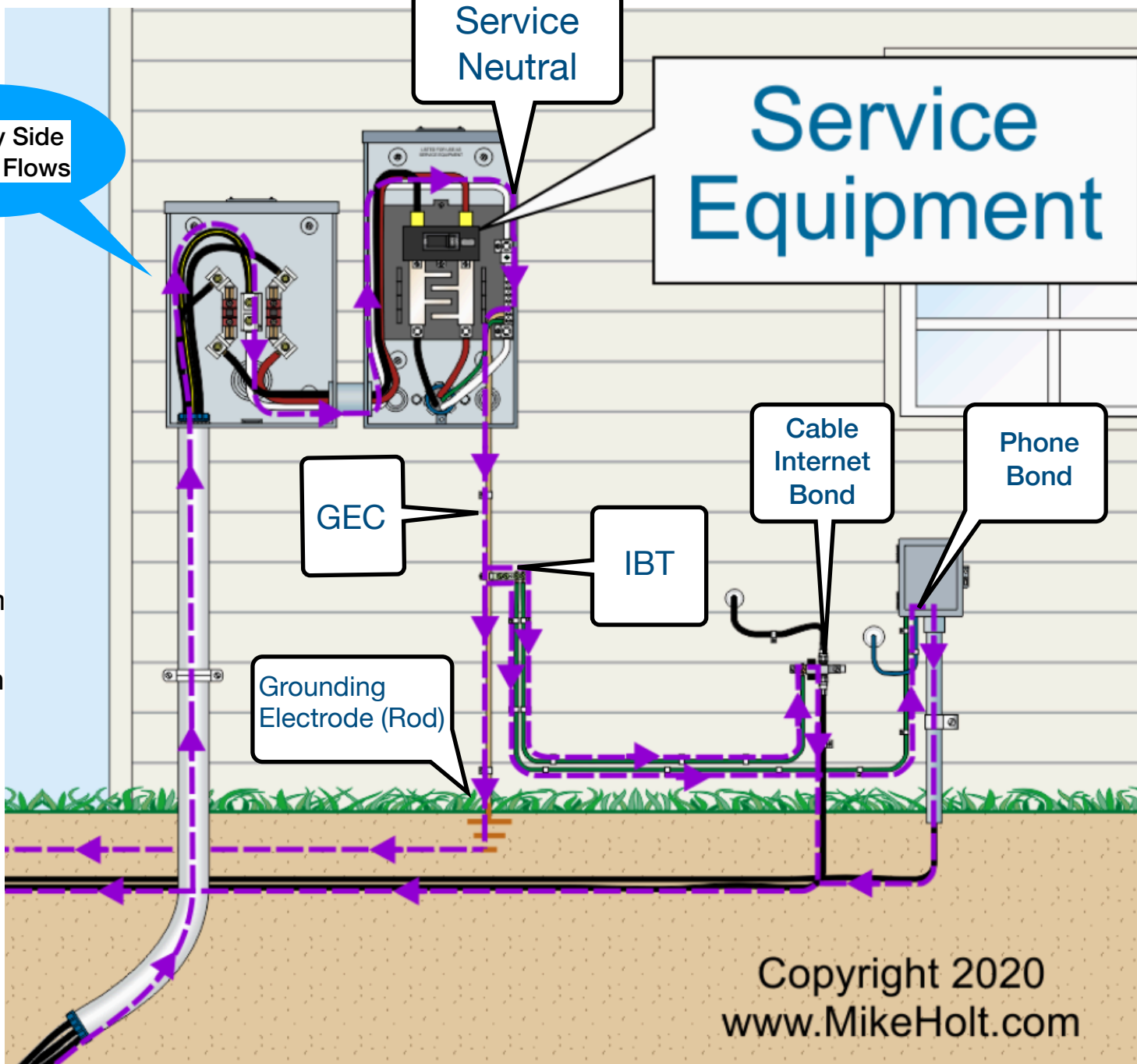
GEC

IBT

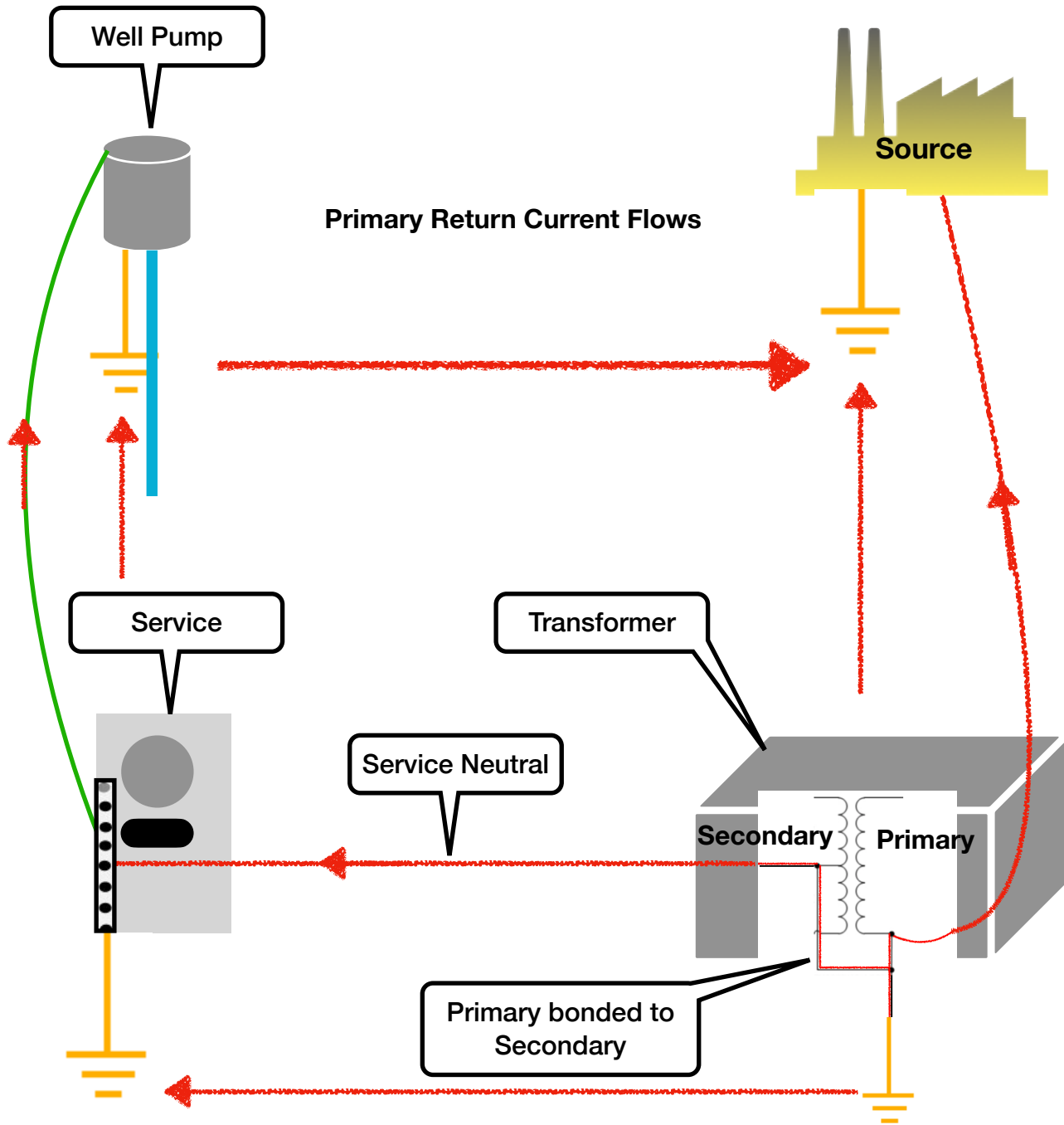
Cable  
Internet  
Bond

Phone  
Bond

Grounding  
Electrode (Rod)



Primary Return Current is both through the earth and the wires/conductors, especially the Service Neutral which connects to Equipment Grounding Conductors associated with any metallic appliance making an electrically conductive connection to earth.

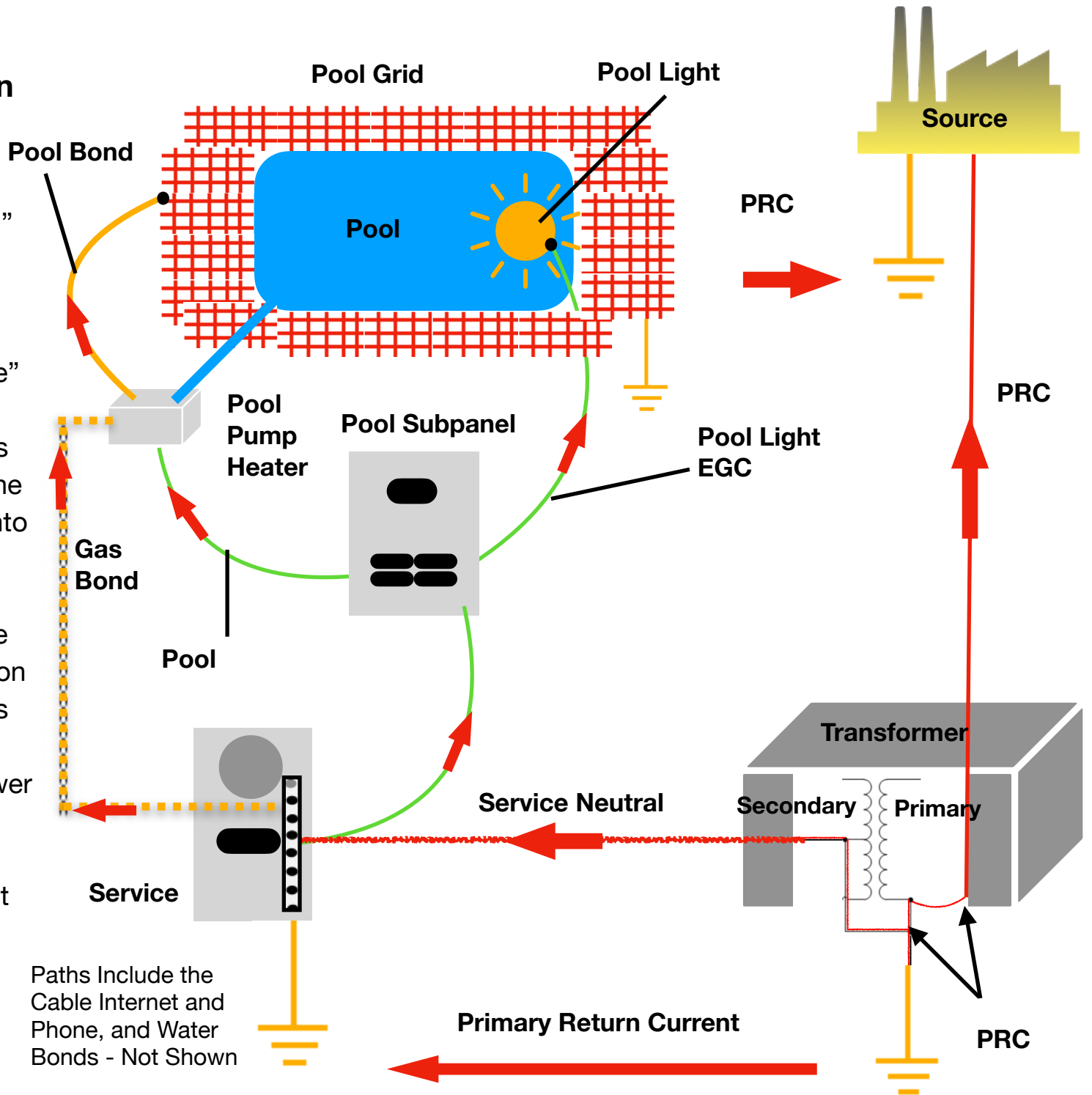


# Primary Return Current (PRC) Paths

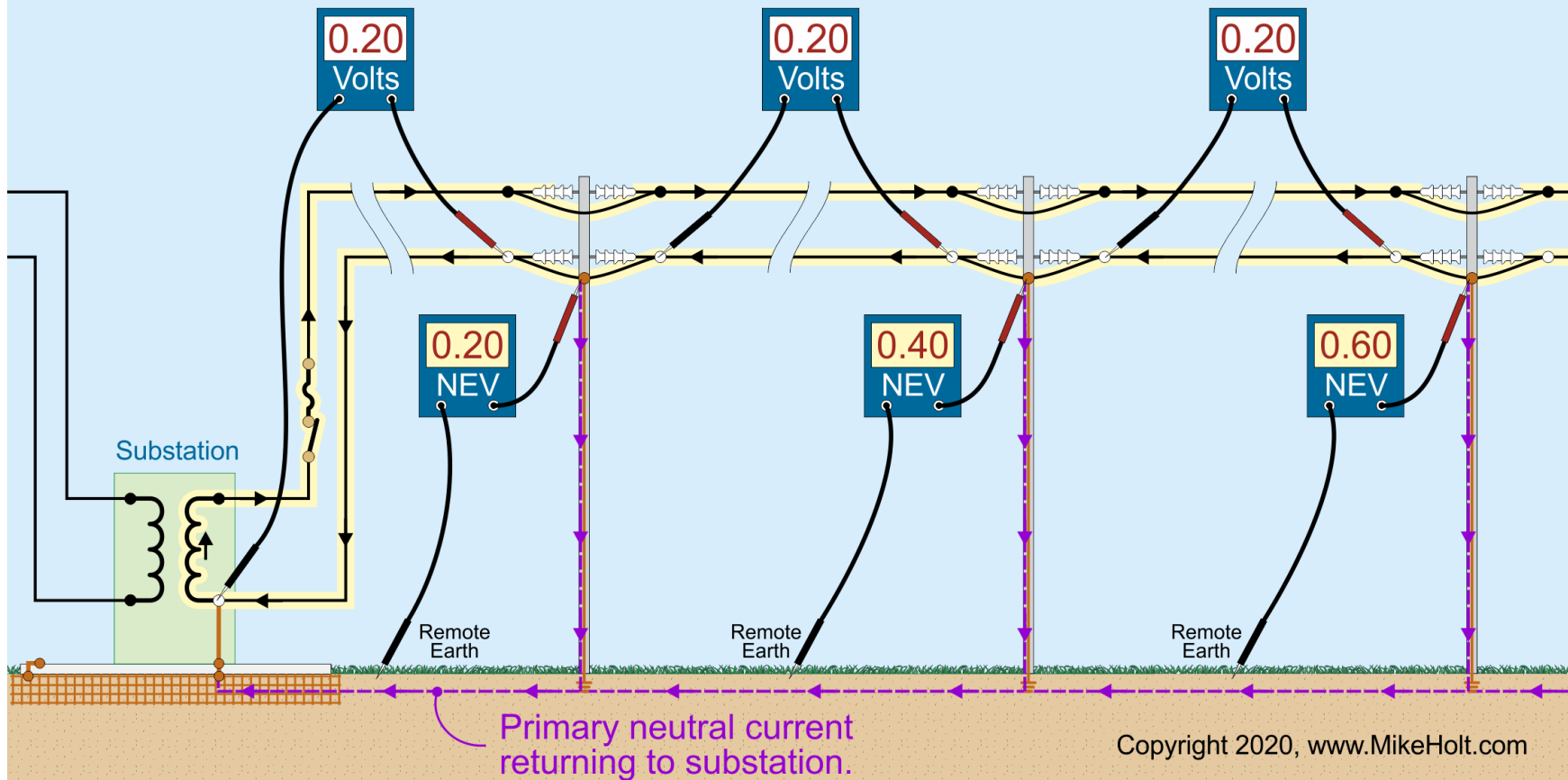
The Primary "grid" side of the transformer is bonded to the Secondary "home" side. This connection allows current through the Service Neutral into our home, to everything grounded, like the pool, a well, etc. on its way back to its Source, the substation or power station.

EGC = Equipment Grounding Conductor

Paths Include the Cable Internet and Phone, and Water Bonds - Not Shown

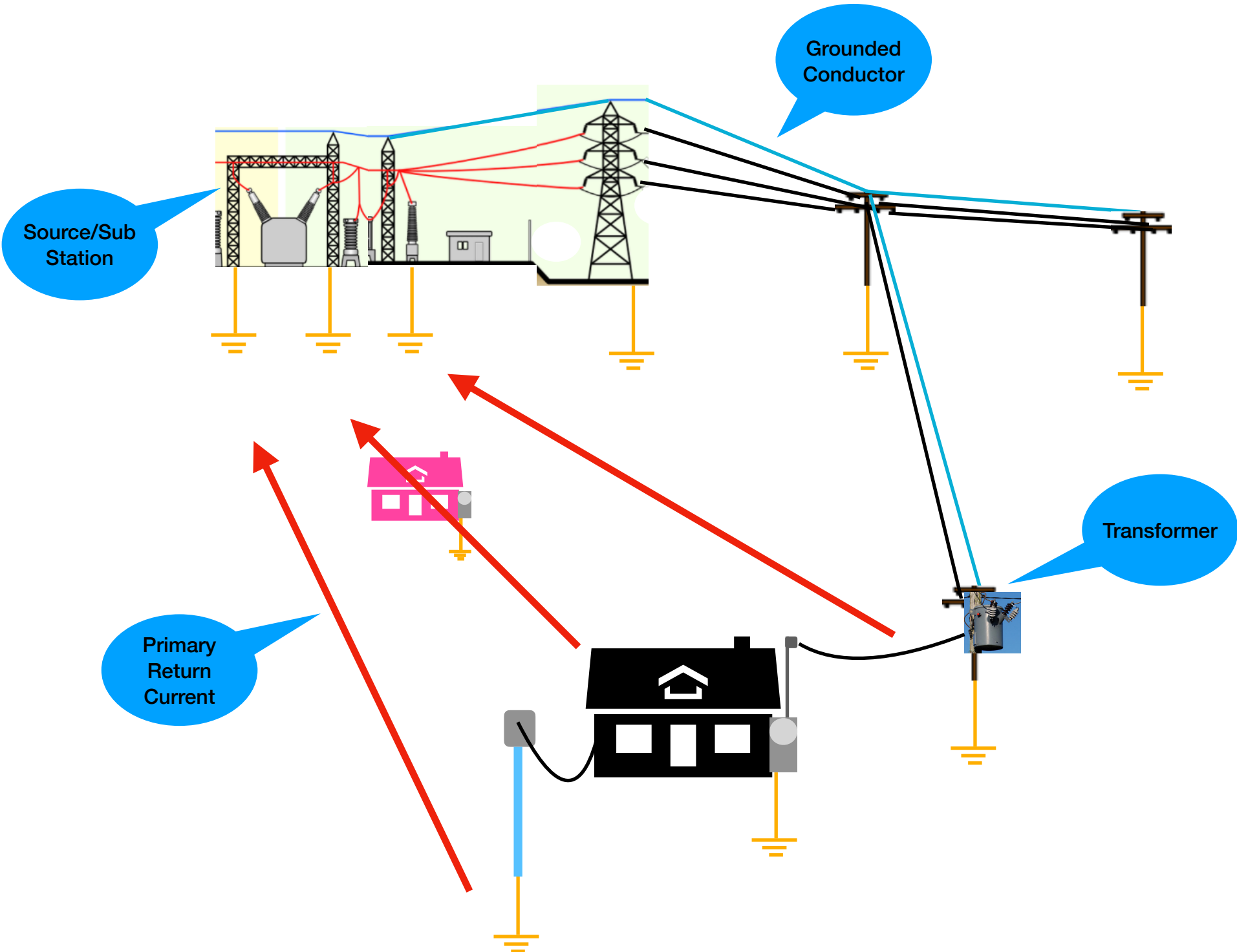


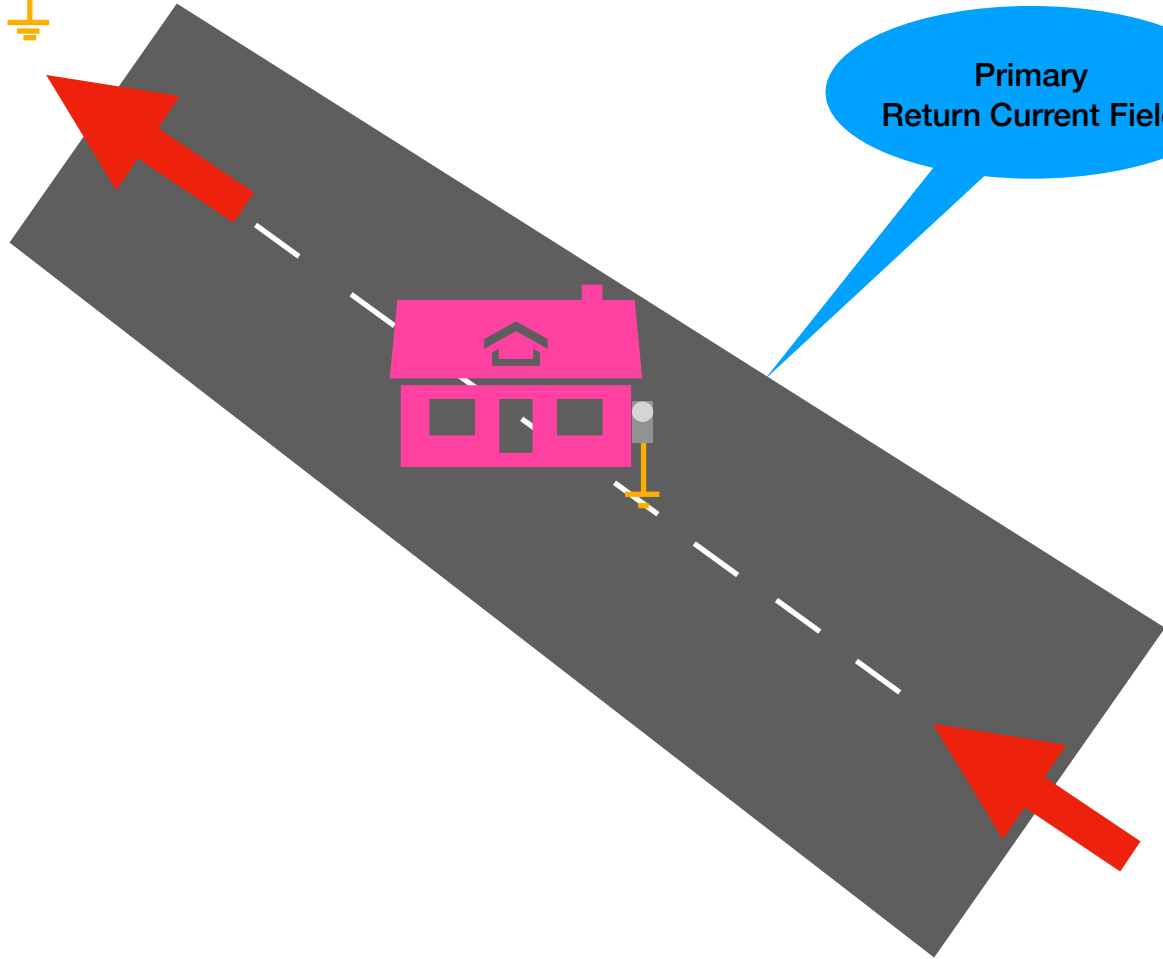
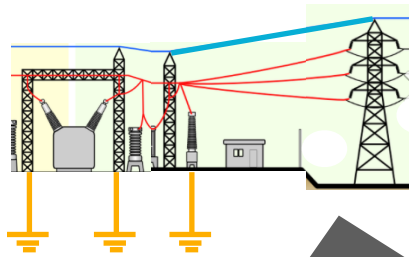
# Neutral-to-Earth Voltage (NEV) Utility Primary Neutral Voltage Drop



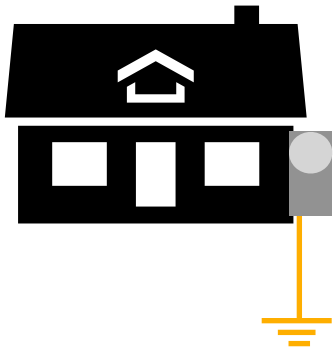
The voltage drop of the primary neutral conductor is dependant on the impedance of the neutral return path and the magnitude of the return current;  $E = I \times R$ .

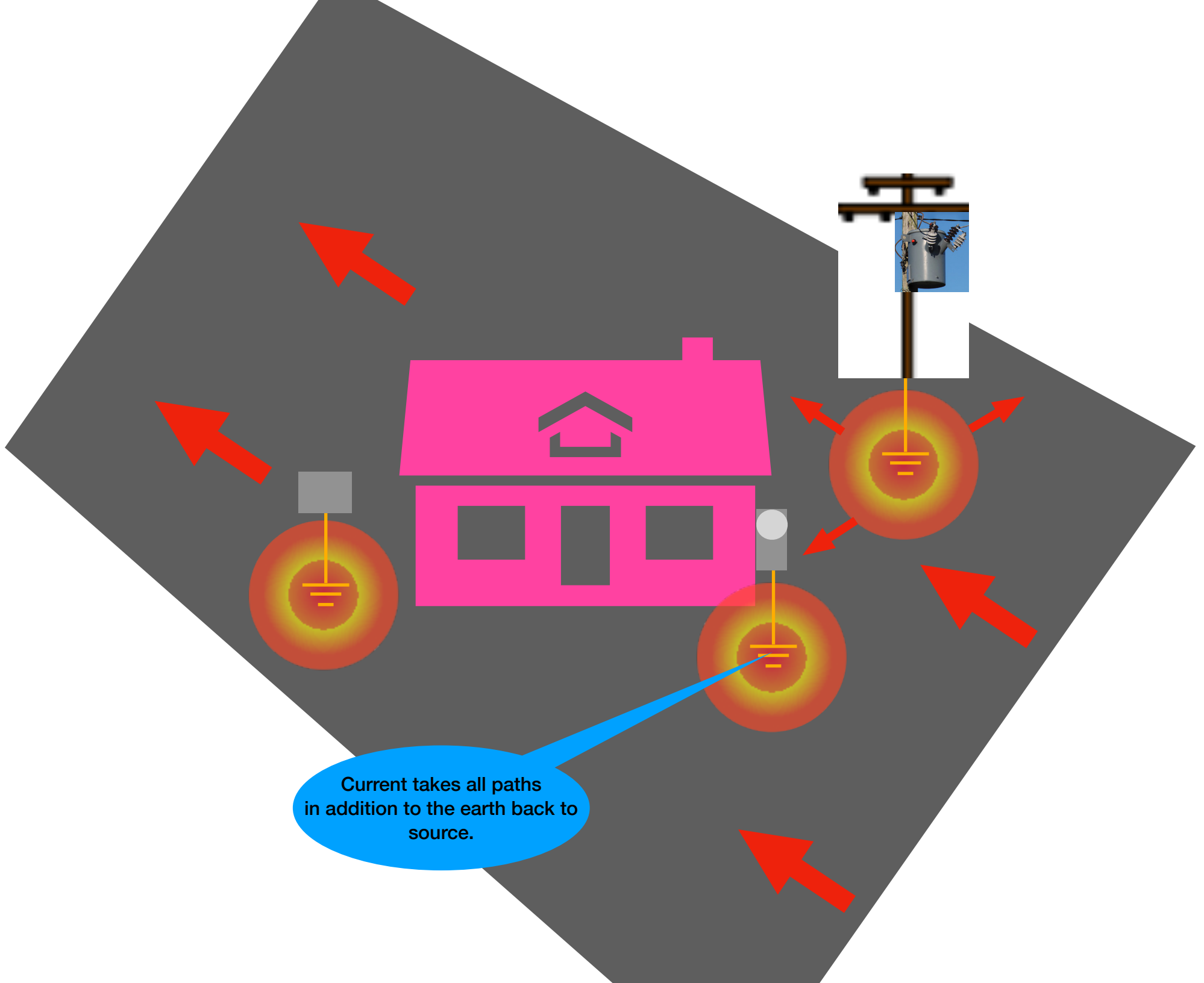




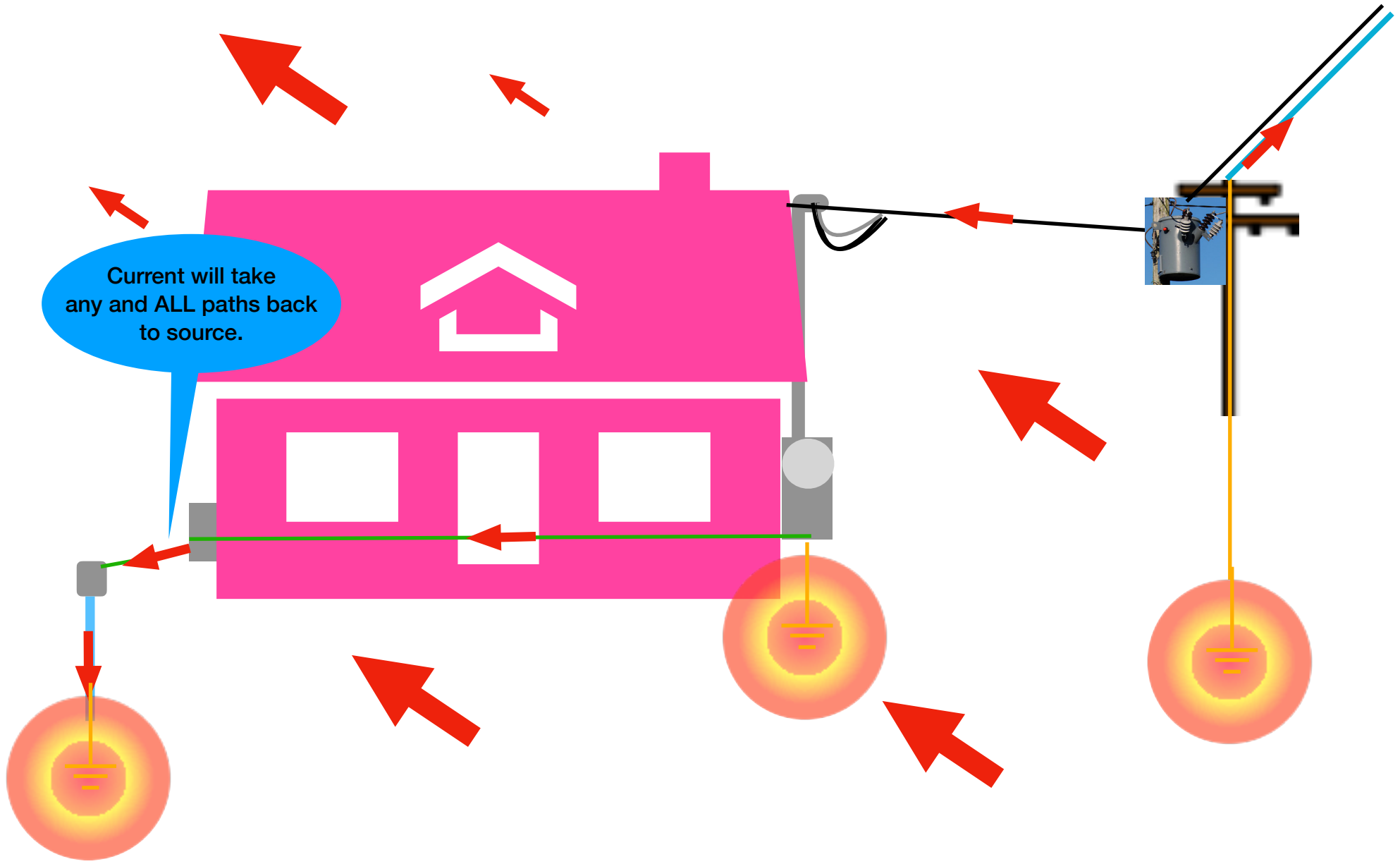


Primary  
Return Current Field



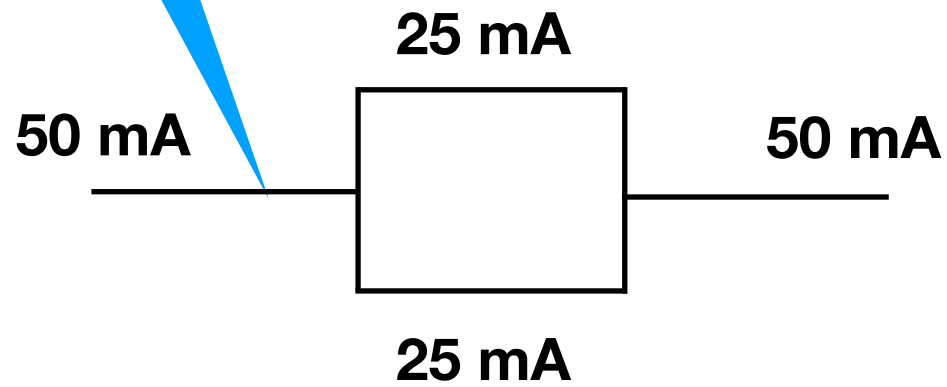


Current takes all paths in addition to the earth back to source.



Current will take any and ALL paths back to source.

50 mA, split into two paths of equal resistance/impedance, will end up having 25 mA on each path.



Sum of foreign current ending up on the Neutral/grounded conductor.

40 mA Phone bond  
400 mA Cable Sheath  
25 mA Path 1  
25 mA Path 2  
10 mA GEC  
=====  
500 mA

40 mA Phone Bond

400 mA Cable

Path 1 has 25 mA

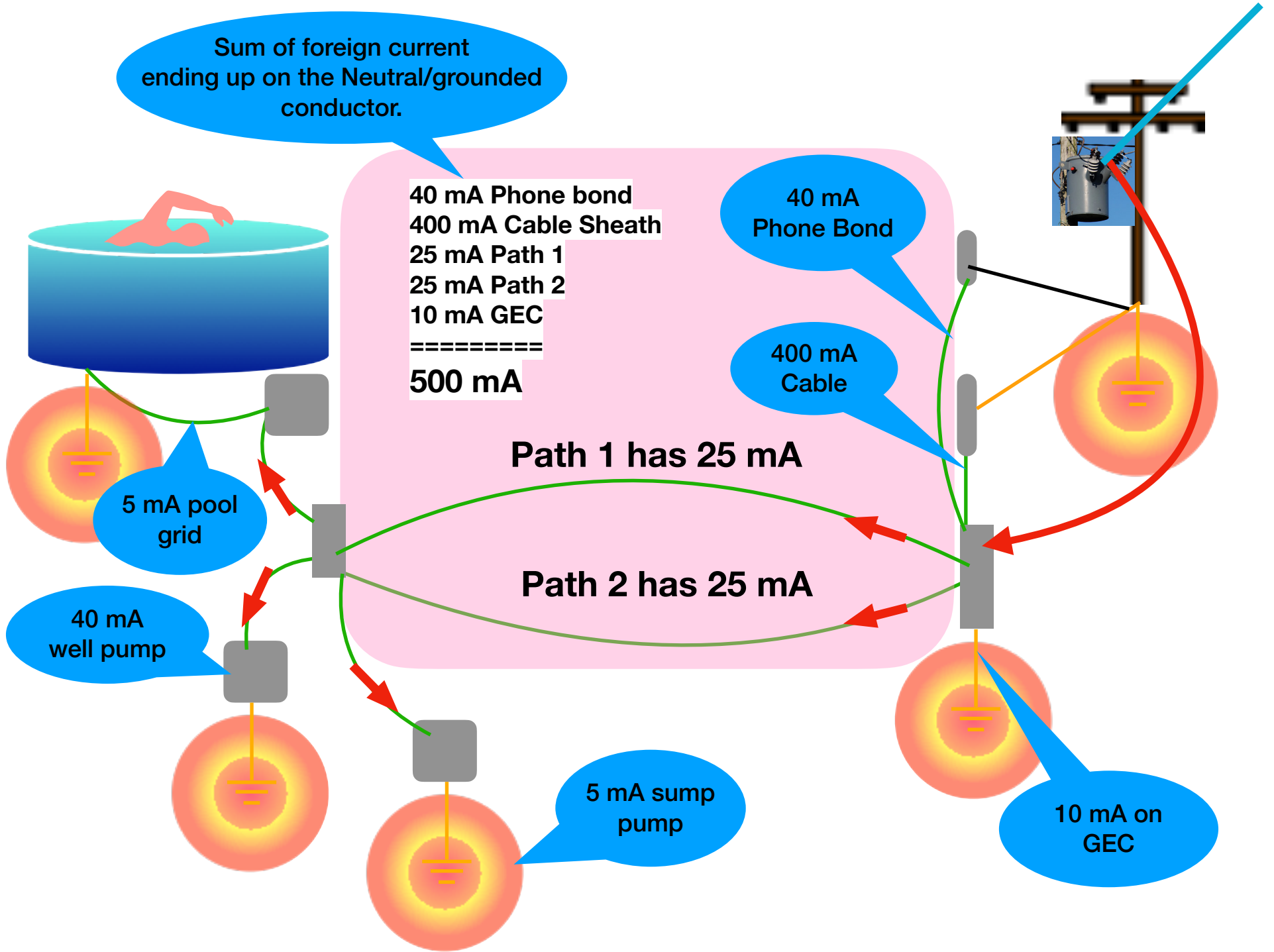
Path 2 has 25 mA

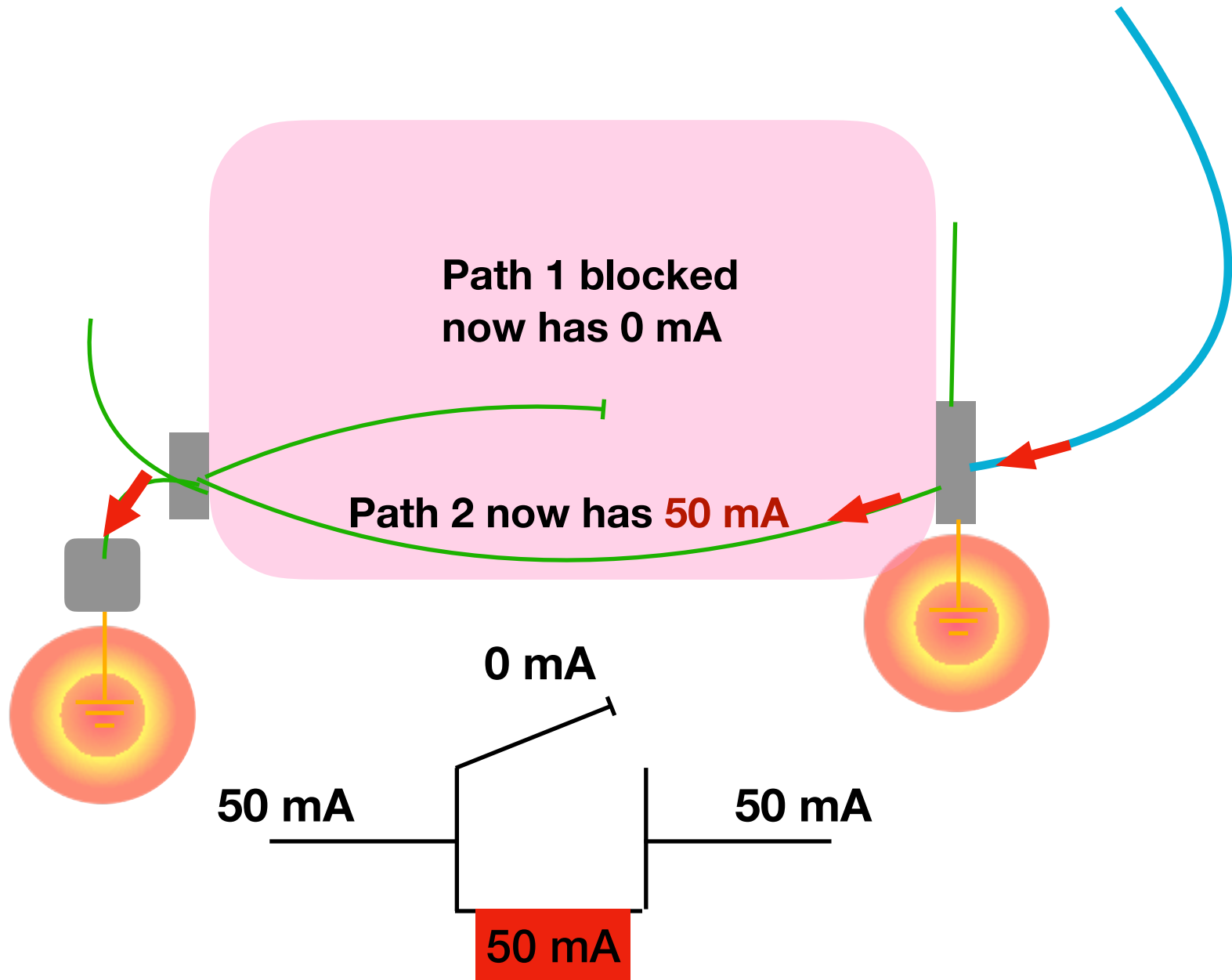
5 mA pool grid

40 mA well pump

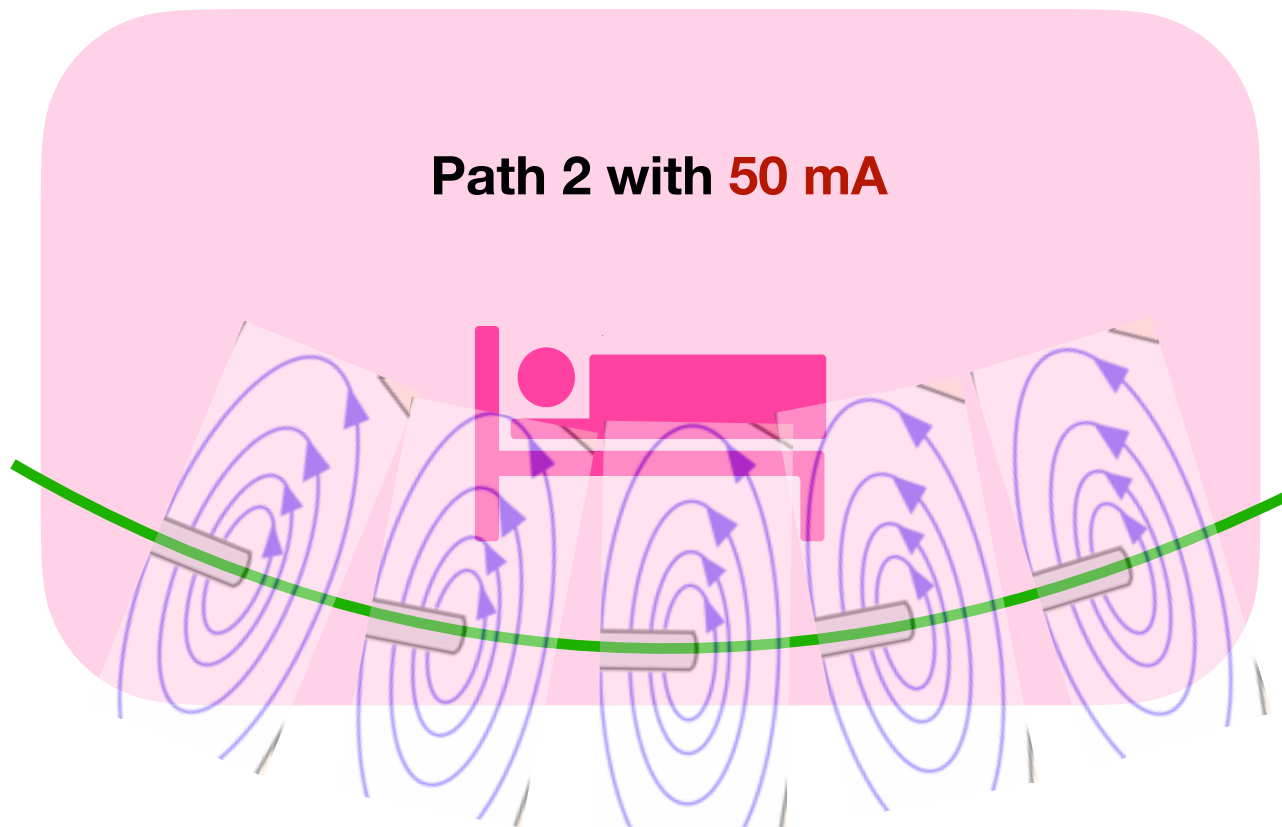
5 mA sump pump

10 mA on GEC





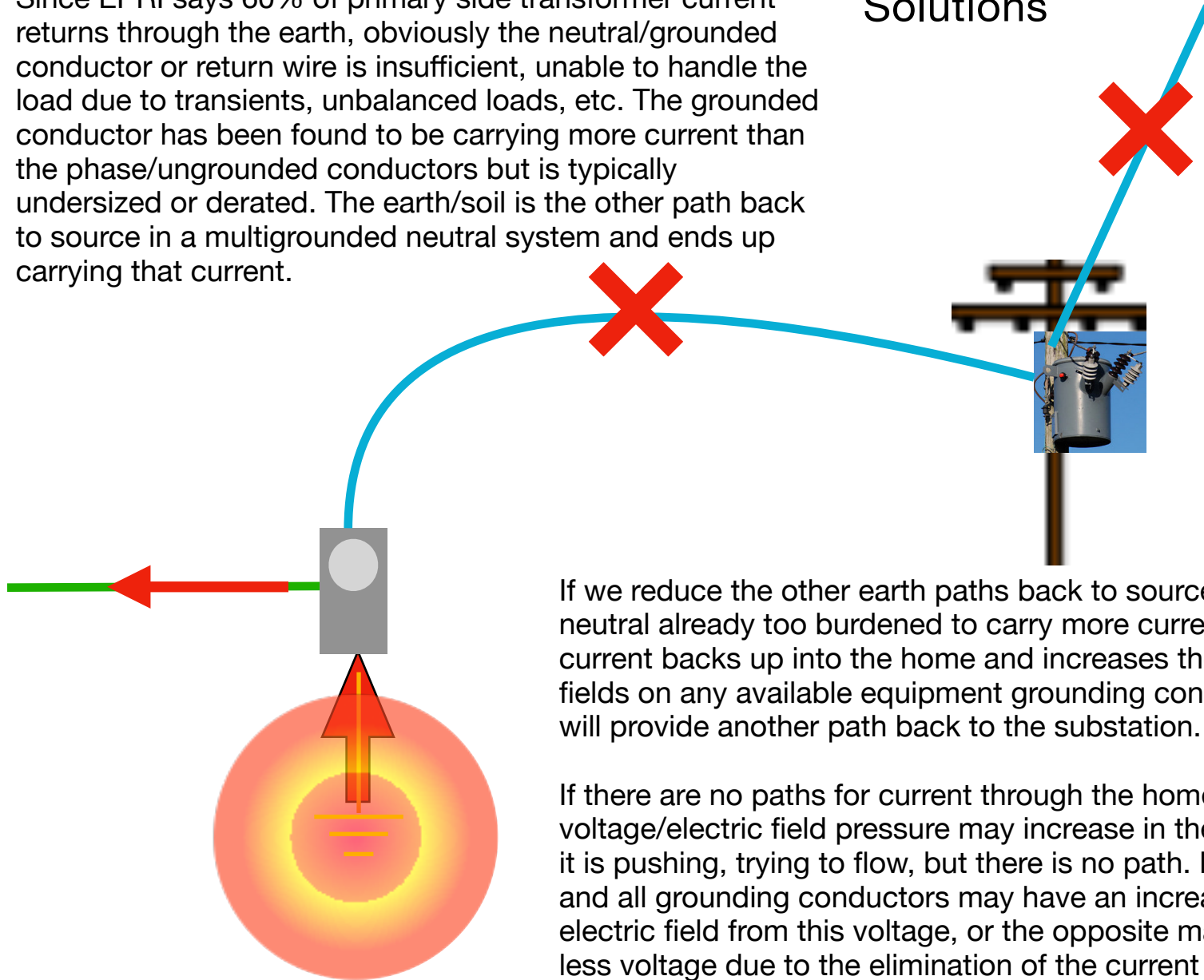
When you reduce the number of paths,  
Magnetic fields will be INCREASED around the  
remaining wires carrying the “foreign” current.





Since EPRI says 60% of primary side transformer current returns through the earth, obviously the neutral/grounded conductor or return wire is insufficient, unable to handle the load due to transients, unbalanced loads, etc. The grounded conductor has been found to be carrying more current than the phase/ungrounded conductors but is typically undersized or derated. The earth/soil is the other path back to source in a multigrounded neutral system and ends up carrying that current.

## Solutions



If we reduce the other earth paths back to source, with the neutral already too burdened to carry more current, the current backs up into the home and increases the magnetic fields on any available equipment grounding conductor that will provide another path back to the substation.

If there are no paths for current through the home, the voltage/electric field pressure may increase in the home as it is pushing, trying to flow, but there is no path. MC cable and all grounding conductors may have an increased electric field from this voltage, or the opposite may occur, less voltage due to the elimination of the current flow. This has to be tested, best with a NFA 1000 bed map picture.

One solution is to oversize or upgrade the neutral/grounded conductor to a more appropriate size to handle the modern demands and return current loads. And the aluminum conductor connections need to be properly maintained. The crimps can be poor, connections corroded (allegedly they are suppose to tighten and have anti-oxidant put on the terminals every 15 years) or simply fix the open neutrals. Since the power company has failed to appropriately size and care for the neutral/grounded conductor, cleaning and oversizing our home's GEC, adding additional electrodes in series, and installing a meter/disconnect combo is the foundation upon which we can immediately reduce this pressure on our home's equipment grounding conductors.

One of the best solutions is what dairy farmers have used and that is installing a neutral blocker on the transformer to cut the path from the primary to the secondary side of the transformer.

Another solution is installing an isolation transformer after your electric meter to establish a new grounding system for your home that won't allow primary return current.

Reducing the sources of dirty electricity from solar inverters, and harmonic producing devices (Variable Speed Drives in AC and pool equipment) will reduce the burden on the neutral.

Having the power company return to using Delta/Delta transformers instead of the Delta/Wye multigrounded neutral system is the long term grid solution. The multigrounded neutral system must go. They must stop putting current into the earth, and directly onto our home grounding system.

By all means, work with your electricians to remove all neutral-to-ground code violations in the home wiring. Install the meter/disconnect to focus the primary return current away from your branch circuits.

Get the majority of the current circulating out at the meter/disconnect, not in a distribution panel. Of special note, do NOT separate the neutral bus bar from the cabinet unless you have added a neutral/ground connection upstream.

Some people have been confused or misinterpreted my isolation of the neutrals from the EGCs described in my books.<sup>4</sup> You must add a N/G connection at the first breaker BEFORE the main panel, the main distribution panel, the branch circuit panel. The best solution is adding a meter/disconnect combo before the main panel which THEN allows the main panel to become a 4 wire subpanel to isolate the neutral from the EGCs.

Cut the water pipes<sup>5</sup> and install dielectric unions on gas pipes as needed to stop the current flows. Oversize the Grounding Electrode Conductor (1/0) and install 2 grounding electrodes.

Beyond this, we are left to take control of the situation by blocking this current using the Nuisance Current Blocker. See the Protocol for the fine tuned use of the NCB, locations and strategies.

Thank you!

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<sup>4</sup> <https://homeemftracing.com/shop/ols/categories/killing-current-series>

<sup>5</sup> <https://homeemftracing.com/shop/ols/products/water-pipe-solution-full-document>

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Figure 16, Figure 17 from:  
**IEEE Std.1695-2016 - IEEE Guide to Understanding, Diagnosing,  
and Mitigating Stray and Contact Voltage.** 8 July 2016, doi:  
10.1109/IEEESTD.2016.7508856.  
<https://ieeexplore.ieee.org/document/7508856>

