SUPPLEMENTAL APPENDIX: PHYSICAL CONSOLIDATION COST ESTIMATE METHODOLOGY

This supplemental appendix is related to the Drinking Water Needs Assessment's Cost Assessment Component. Learn more here: Appendix: Cost Assessment Methodology.

CONTENTS

COST ESTIMATE METHODOLOGY FOR EACH PHYSICAL CONSOLIDATION COMPONENT

INTRODUCTION

The *Drinking Water Needs Assessment's* Cost Assessment methodology utilizes a model to estimate the financial costs of both necessary interim measures and longer-term solutions to bring Failing list systems into compliance and address the challenges faced by High-Risk state small water systems and domestic well as identified via the Risk Assessment. The goal of the Cost Assessment is to inform the spending prioritization of existing funding sources, particularly via the SB 200-mandated annual *Safe and Affordable Drinking Water Fund Expenditure Plan*, as well as to identify potential additional funding sources to leverage, and to estimate the size of the current funding gap to continue to advance the Human Right to Water for all Californians.

Physical consolidation is one of many possible long-term solutions modeled in the Cost Assessment. "Consolidation" means joining two or more public water systems, state small water systems, or affected residences (domestic well) into a single public water system[1], either physically or managerially. For example, a small mobile home park that operates its own water system may be near or within a city (i.e. Receiving system) and decides it no longer wishes to be responsible for providing drinking water. The city can begin providing water to the mobile home park through a master meter or other type of connection. Some of the benefits of physical consolidation include:

- The Receiving water system may already have adequate treatment or the ability to construct water treatment that is designed to address the water quality challenges that impact area water supplies.

- The Receiving water system may offer a diversified water supply portfolio affording optimization of available area water supplies to ensure that its population will not be faced with shortages. This alleviates small systems' issues with a lack of storage, inadequate pumping capacity, or inadequate individual well productivity.

- Consolidation of treatment and operations can improve water rate affordability in the long run by spreading costs over a larger customer base, decreasing redundant efforts, and decreasing treatment costs through larger bulk purchases.

The physical consolidation methodology detailed in this Appendix was developed to identify potential physical consolidation projects for estimating statewide funding needs for Failing and At-Risk systems. While engineering and cost-modeling play a large role in physical consolidation and regionalization, that State Water Board recognizes that the actual long-term solution that will be implemented by the water systems and communities included in the Cost Assessment may be highly variable depending on other factors such as political boundaries, water rights boundaries, community interests, and other factors.

It is important to note that the Cost Assessment is not intended to identify actual community solutions. The purpose of the Cost Assessment is to estimate drinking

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[1] Health & Saf. Code, § 116681, subd. (e).

water costs to provide safe, potable, and wholesome drinking water. An evaluation of each system will be needed to identify and cost a range of solutions.

PHYSICAL CONSOLIDATION METHODOLOGY DEVELOPMENT

The Cost Assessment Model's development and enhancement process is designed to encourage public and stakeholder participation, providing opportunities for feedback and recommendations. The physical consolidation analysis included in the Cost Assessment Model has gone through two iterations, incorporating feedback from seven public workshops. The first physical consolidation analysis was conducted for the *2021 Drinking Water Needs Assessment*. The second iteration of the physical consolidation analysis was updated and enhanced for the *2024 Drinking Water Needs Assessment*. The following sections provide an overview of the work.

VERSION 1.0 (2021)

The first iteration of the physical consolidation analysis conducted for the *2021 Drinking Water Needs Assessment* was developed by the State Water Board, in partnership with the University of California, Los Angeles Luskin Center for Innovation, Corona Environmental Consulting, and Sacramento State University Office of Water Programs. Three public workshops were hosted to solicit public feedback on the physical consolidation analysis methodology and underlying cost assumptions:

May 10, 2019: *Cost Analysis Workshop*
- Public Notice
- Agenda
- Webcast Recording
- Consolidation-Related Presentation PDFs:
  - SWRCB DDW, D. Polhemus
  - Corona Environmental Consulting, T. Henrie
  - UCLA, Y. Cohen
  - Los Angeles County Sativa, D. Lafferty

August 28, 2020: *Cost Estimate: Overview of Approach and Update*
- Public Notice
- White Paper
- Webinar Recording

November 20, 2020: *Cost Estimate: In-Depth Cost Methodology Discussion Webinar*
- Public Notices: English | Spanish
- White Paper
- Presentation
- Webinar Recording

In addition to the public feedback solicited during the workshops, the State Water Board received a handful of comment letters throughout this effort and some adjustments to the Cost Methodology were made as a result. Additional details that were requested in the comment letters have been added to this 2021 Cost Assessment Methodology Appendix.

More information can be found on the State Water Board's Drinking Water Needs Assessment website.[2]

VERSION 2.0 (2024)

From 2022 – 2023, the State Water Board hosted a series of four webinar workshops to solicit stakeholder feedback on updates and enhancements to the Cost Assessment Model. The workshop dates and corresponding white papers, presentations, and webinar recordings are provided below. The second workshop was solely focused on the proposed updates to the physical consolidation analysis; however, all of the other workshops included some information related to the physical consolidation analysis.

August 8, 2022: *Proposed Changes for the Cost Assessment*
- Public Notices: English | Spanish
- White Paper
- Presentation
- Webinar Recording

July 14, 2023: *Proposed Updates to the Drinking Water Cost Assessment Model – Workshop 1: Physical Consolidation Analysis*
- Public Notices: English │ Spanish
- White Paper
- Presentation
- Webinar Recording

October 5, 2023: *Proposed Updates to the Drinking Water Cost Assessment Model – Workshop 2: Modeled Treatment Analysis*
- Public Notice: English │ Spanish
- White Paper: *See Appendix D for public feedback on the Physical Consolidation Analysis white paper.*
- Presentation
- Webinar Recording

December 20, 2023: *Proposed Updates to the Drinking Water Cost Assessment Model – Workshop 3: Other Essential Infrastructure, Administrative Needs, and Interim Solutions*
- Public Notice: English │ Spanish
- White Paper: *See preliminary physical consolidation analysis results starting on Page 18.*
- Presentation
- Webinar Recording

Below is a brief summary of the changes made to the physical consolidation analysis compared to the methodology used in the 2021 Cost Assessment:

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[2] Drinking Water Needs Assessment Website
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/needs.html

- Determine if physical consolidation is a viable model solution initially before modeling other potential solutions.
- Update the criteria used to identify which water systems are included in the physical consolidation analysis. A core recommendation is to include large/medium Failing systems as possible Receiving systems.
- Update the criteria used in the physical consolidation analysis to identify potential Joining state small water systems and domestic wells.
- Update physical consolidation unit cost assumptions using internal and external quotes and resources.
- Apply inflation and other cost adjustments to the subtotal construction cost estimates.
- Increase physical consolidation cost viability thresholds based on the most recent State Water Board Intended Use Plan (IUP) and include a 20% buffer to accommodate uncertainty.
- Utilize new funding viability thresholds for state small water systems and domestic wells.
- Calculate additional costs for physical consolidation projects that meet the distance and cost viability thresholds and then add to the summed total:
    - Treatment cost for model-selected Failing Receiving water systems.
    - Additional source costs for the Receiving system if it has a single source.
    - Additional "Other Essential Infrastructure" (OEI), Administrator, Technical Assistance, and other additional costs as determined by the Cost Assessment Model.

The following sections in this Supplemental Appendix detail the current physical consolidation analysis methodology and cost assumptions.

SUMMARY OF CURRENT PHYSICAL CONSOLIDATION ANALYSIS METHODOLOGY

The State Water Board has been tracking the performance of community water systems and K-12 schools since 2017 with Failing criteria and since 2021 with the Risk Assessment. This analysis highlights that small water systems[3] disproportionally fail more frequently and are more likely to be At-Risk of failing to sustainability provide a sufficient amount of safe and affordable drinking water. Additionally, smaller water systems have less financial capacity and higher rates when compared to larger water systems. A core vision of the State Water Board's SAFER program is to promote physical consolidations where feasible to help achieve greater economies of scale and advance the goals of Human Right to Water.

In the Cost Assessment Model, physical consolidation analysis is conducted in advance of any other modeled solution for Failing and At-Risk systems to ensure that it is the first solution considered. If physical consolidation is not a viable modeled solution, the Cost Assessment Model will then identify an alternative long-term modeled solution that addresses the system's Failing criteria and/or risk drivers.

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[3] Small water systems are systems with 3,000 service connections or less.

Figure 1: Steps for Physical Consolidation Analysis
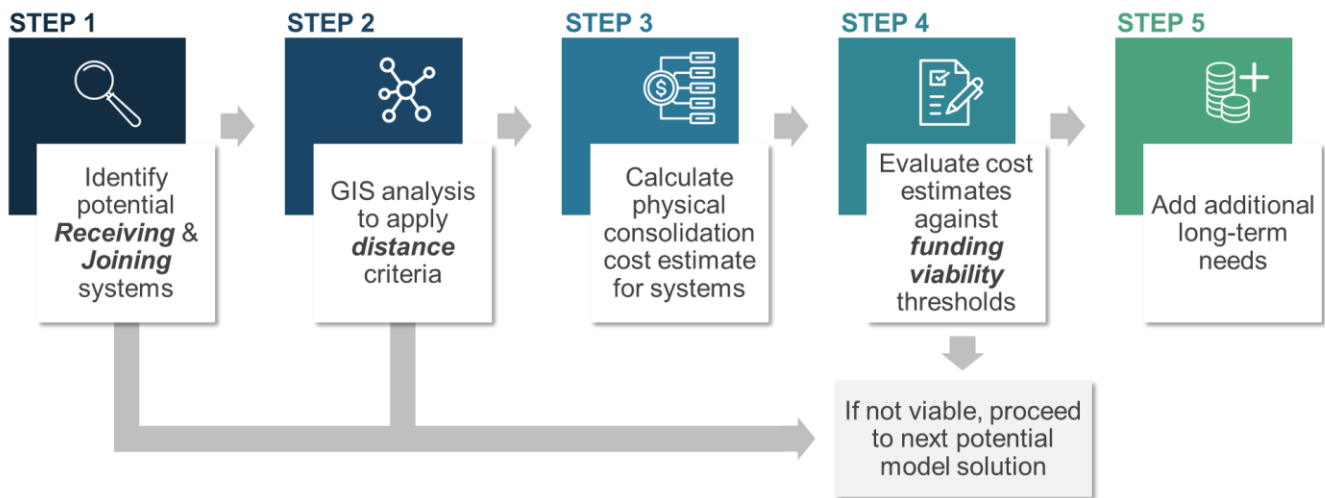
The following is a summary of the steps taken by the Cost Assessment Model to conduct the physical consolidation analysis:

STEP 1: Identification of systems (inventory) to include in the modeled physical consolidation analysis as possible Receiving and Joining systems.

STEP 2: Conduct GIS analysis to determine which Joining systems meet the physical consolidation distance viability criteria to possible Receiving systems.

STEP 3: Calculate estimated modeled physical consolidation project costs for systems that meet the inventory and distance criteria.

STEP 4: Determine if the modeled physical consolidation project cost estimate meets the Model's funding viability thresholds.

STEP 5: Model additional long-term needs for systems where physical consolidation meets the funding viability thresholds.

STEP 6: Systems where physical consolidation does not meet the inventory criteria, distance criteria, and/or funding viability threshold will move forward in the Cost Model to identify alternative modeled long-term solutions.

The following sections and corresponding appendices provide a detailed guide for how the physical consolidation analysis is conducted within the Cost Assessment Model.

PHYSICAL CONSOLIDATION ANALYSIS METHODOLOGY

STEP 1: IDENTIFICATION OF POSSIBLE RECEIVING & JOINING SYSTEMS

The physical consolidation analysis conducted within the Cost Assessment Model includes community water systems, non-transient non-community (NTNC) K-12 schools, state small water systems, and domestic wells. The analysis identifies potential one-to-one physical consolidations between two different systems. These systems are classified in the Cost Assessment Model as either "Receiving" or "Joining" systems:

- **Receiving Systems**: Commonly larger public water systems that expand to subsume Joining systems and provide water supply to both of their customers.

- **Joining Systems**: Commonly smaller public water systems, state small water systems, and domestic wells that are dissolved into existing receiving public water systems and are no longer responsible for providing water to their own customers.

Figure 2: Physical Consolidation
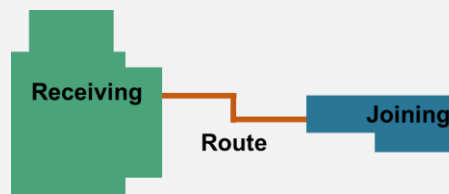
The Cost Assessment Model requires the development of criteria for which water systems should be considered Receiving and Joining systems. The criteria used to determine which systems are included in the analysis is based on two categories: "**SAFER Status**" of the system and the system's size (number of service connections).

The "**SAFER Status**" of water systems and domestic wells is based on the State Water Board's Failing criteria (public water systems only) and the results of the Risk Assessment (all system types). A brief definition of each **SAFER Status** is provided bellow:

- **Failing Water Systems**: community water systems and NTNC K-12 schools. Those systems were identified to be out of compliance for consistently failing to meet drinking water standards. Currently there are five failing criteria[4]: Primary MCL violation, Secondary MCL violation, E. coli violations, treatment technique violations, and

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[4] Failing Water Systems:
https://www.waterboards.ca.gov/water_issues/programs/hr2w/docs/hr2w_expanded_criteria.pdf

monitoring & reporting violations. All Failing systems regardless of their Failing criteria are assessed for physical consolidation within the Cost Assessment Model.

- **At-Risk Water Systems and Domestic Wells**: community water systems with up to 30,000 service connections and 100,000 population served, NTNC K-12 schools, state small water systems, and domestic wells that are at-risk of failing to deliver safe and affordable drinking water. All At-Risk water systems and domestic wells are assessed for physical consolidation within the Cost Assessment Model regardless of their risk drivers.

- **Potentially At-Risk Public Water Systems**: community water systems with up to 30,000 service connections and 100,000 population served, NTNC K-12 schools, potentially at-risk of failing to deliver safe and affordable drinking water.

- **Not At-Risk Public Water Systems**: community water systems, NTNC K-12 schools, that are not at-risk of failing to deliver safe and affordable drinking water.

- **Not Assessed Public Water Systems**: community water systems excluded from the Risk Assessment inventory with more than 30,000 service connections and 100,000 population served, those systems were added to the physical consolidation inventory and assessed as potential Receiving systems.

Table 1: Cost Assessment Model's Joining & Receiving System Criteria

	Criteria
Joining Systems:	
Failing Public Water Systems	≤ 1,000 service connections.
At-Risk Public Water Systems	≤ 500 service connections.
Potentially At-Risk, Not At-Risk, & Not Assessed Public Water Systems	*Excluded*
State Small Water Systems & Domestic Wells	High-Risk in the *Water Quality* and/or *Water Shortage* categories in the Risk Assessment.
Receiving Systems for Joining Public Water Systems:	
Failing Public Water Systems	*Largest System* **>** 1,000 service connections.
At-Risk Public Water Systems	*Largest System* **>** 500 service connections.
Potentially At-Risk, Not At-Risk, Not Assessed Public Water Systems	*Largest System* **>** 500 service connections.
State Small Water Systems & Domestic Wells	*Excluded*

	Criteria
Receiving Systems for Joining State Small Water Systems & Domestic Wells:	
Failing Public Water Systems	*Largest Nearby System*
At-Risk Public Water Systems	*Largest Nearby System*
Potentially At-Risk, Not At-Risk, Not Assessed Public Water Systems	*Largest Nearby System*
State Small Water Systems & Domestic Wells	*Excluded*

STEP 2: DETERMINE WHICH SYSTEMS MEET MODELED PHYSICAL CONSOLIDATION DISTANCE CRITERIA TO POSSIBLE RECEIVING SYSTEM

The Cost Assessment Model's physical consolidation analysis includes a spatial GIS analysis to identify if the inventory of potential Joining and Receiving systems determined in Step 1 meet physical consolidation distance criteria. Step 2's GIS analysis identifies three different types of physical consolidations (Figure 3):

- **Intersect**: Where the Joining system, state small water system, or domestic well is physically located within the service area boundary of a potential Receiving system.

- **Route**: Where the Joining system is physically located within a maximum distance from the service area boundary of a potential Receiving system along a street.

- **Route Intersect**: Where the Joining state small water system or domestic well is along the modeled route of a potential public water system[5] physical consolidation.

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[5] State small water system physical consolidation routes are excluded from this analysis.

Figure 3: Possible Modeled Physical Consolidations

INTERSECT | ROUTE | ROUTE INTERSECT

■ Receiving System ■ Joining System ● State Small Water System ● Domestic Well
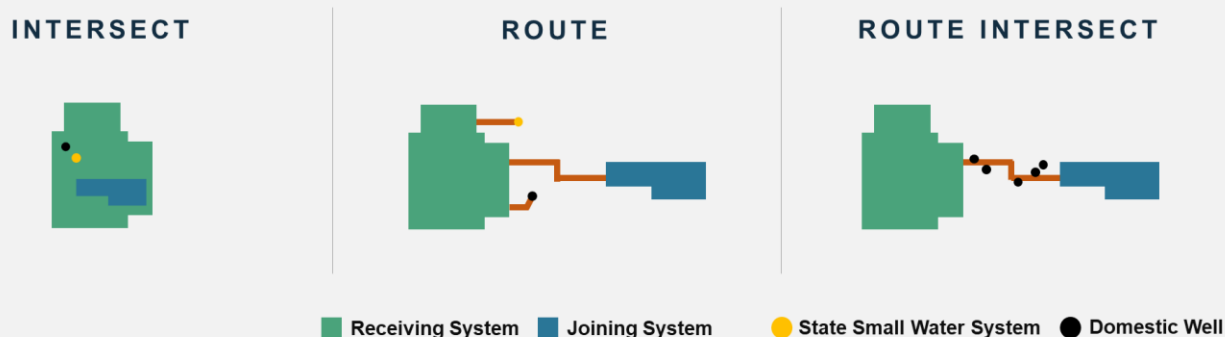
Appendix A provides the in-depth methodology for conducting the GIS analysis necessary for Step 2.

The Cost Assessment Model assumes all potential Joining systems that intersect with a possible Receiving public water system's service area boundary meet the distance viability criteria. For non-intersecting systems, the Cost Assessment Model selects the *largest* potential Receiving system in the physical consolidation analysis based on the shortest distance to a potential Joining system. The maximum viable modeled distance for public water systems is 3 miles from the boundary of a potential Receiving system to the centroid of the potential Joining system. For potential Joining state small water systems and domestic wells, the maximum viability distance is 0.38 miles from the possible Receiving community water system's boundary. For potential Joining domestic wells, those that can be picked up along the pipeline route between Receiving and Joining community water systems are also considered viable. See distance criteria summarized in the Table 2 below.

Table 2: Distance Criteria for Physical Consolidation Analysis

	Viability Criteria
Public Water Systems	• ***Intersect*** • ***Route:*** Maximum route distance = 3 miles
State Small Water Systems	• ***Intersect*** • ***Route***: Maximum route distance = 0.38 miles • ***Route Intersect:*** Systems that intersect a viable public water system's modeled physical consolidation route.
Domestic Wells	• ***Intersect*** • ***Route:*** Maximum distance = 0.38 miles • ***Route Intersect:*** Domestic wells located within a 1-mile section that intersects a viable public water system's modeled physical consolidation route.

Systems included in the Cost Assessment Model that do not meet the Joining and Receiving system inventory or distance criteria will then move forward in the Cost Assessment Model for evaluation of alternative possible modeled long-term solutions, i.e., treatment, technical assistance, etc. Learn more in the Cost Assessment Supplemental Appendixes: Centralized Treatment,[6] Decentralized Treatment,[7] and Additional Long-Term Solutions.[8]

STEP 3: CALCULATE ESTIMATED PHYSICAL CONSOLIDATION PROJECT COSTS

The estimated cost for physical consolidation is determined for the water systems and domestic wells that meet both the inventory criteria in Step 1 and the distance criteria in Step 2. The Cost Assessment Model will then apply cost assumptions to each modeled physical consolidation to develop a cost estimate. The State Water Board conducted significant research and outreach to develop the cost component estimates included in the Cost Assessment Model. Table 3 below summarizes the list of components used in the physical consolidation cost estimate. **Appendix B provides a detailed overview of how these cost estimates are conducted for each modeled physical consolidation identified in Step 3.**

Table 3: Summary of Physical Consolidation Cost Estimate Components

Cost Component	Application	Cost Estimate ($)
Pipeline ($/Lf)	Based on modeled route.	$220
Connection Fees ($/Joining system service connection)	Averaging connection fees for Receiving systems for each scenario	• **Public Water Systems** = $5,437 • **SSWS** = $2,600 • **DW** = $3,342
Service Line Cost ($/Project)	Included for both intersect and route Joining systems	$6,200
Administrative Cost ($/Project)	Included for all Failing and At-Risk systems, except At-Risk Domestic wells	15% of total construction cost.
CEQA Cost ($/Project)	• Included for all Failing and At-Risk systems, except At-Risk DWs	• **Intersect** systems = $25,000

[6] Supplemental Appendix: Centralized Treatment Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-centralized-treatment.pdf
[7] Supplemental Appendix: Decentralized Treatment Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-decentralized-treatment.pdf
[8] Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-add-longterm-solutions.pdf

Cost Component	Application	Cost Estimate ($)
		• **Route** systems = $100,000
Treatment Cost	Included for Failing Receiving systems due to water quality issues	Apply BAT[9] Capital and O&M[10] per failing analyte. (*excluded from physical consolidation funding viability determination*)
Additional Source	Included for Receiving systems with single source of water supply.	Additional cost for well if system relies on one source. (*excluded from physical consolidation funding viability determination*)
Contingency	Included for all Failing and At-Risk systems, except At-Risk DWs	20% Total cost
Inflation	Included for all systems regardless of size and type	3.1% Total cost
Planning & Construction	Included for all systems regardless of size and type	10% Total cost
Regional Multiplier	Included for all systems regardless of size and type	• Rural Counties (0%) • Urban Counties (+32%) • Suburban Counties (+30%)

STEP 4: DETERMINE IF PHYSICAL CONSOLIDATION COST ESTIMATES MEET MODEL FUNDING VIABILITY THRESHOLDS

If a water system or domestic well meets the system criteria in Step 1 and the distance viability criteria in Step 2, then the Cost Assessment Model will assess if the estimated capital costs, calculated in Step 3, meet the modeled physical consolidation funding viability threshold in Step 4.

For modeled physical consolidation projects involving public water systems, the funding viability thresholds were determined based on funding priorities outlined in the 2023-24 Intended Use Plan.[11] The 2023-24 Intended Use Plan sets physical consolidation funding

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[9] Best available technology (BAT).
[10] Operations and maintenance (O&M).
[11] Clean Water State Revolving Fund Intended Use Plan
https://www.waterboards.ca.gov/water_issues/programs/grants_loans/docs/2023/2023-24-cwsrf-iup.pdf

thresholds for public water systems to: (1) total capital costs less than $6 million; or (2) capital costs per connection less than $80,000.

The State Water Board's internal Cost Assessment Model workgroup comprised of Division of Drinking Water and Division of Financial Assistance staff, recommended inflating the Intended Use Plan funding viability thresholds by 20% in the Cost Assessment Model to account for inherent limitations in modeling physical consolidation costs.

The State Water Board developed a funding viability threshold of a maximum of $2 million for modeled physical consolidation of a state small water systems and $150,000 for a domestic well. Table 4 below summarizes the funding viability thresholds utilized in the Cost Assessment Model.

It is important to note that these funding viability thresholds for state small water systems and domestic wells were developed for the Cost Assessment Model only and are not included in the 2023-24 Intended Use Plan. The Division of Financial Assistance does not currently employ funding viability thresholds for consolidation projects for state small water systems and domestic wells. Funding decisions are made on a case-by-case basis.

Table 4: Cost Assessment Model's Funding Viability Thresholds for Modeled Consolidation Projects

	Funding Viability Criteria
Public Water System *> 75 service connections*	Estimated Capital Cost per Connection < $96,000
Public Water System *< 75 service connections*	Estimated Total Capital Cost < $7.2 million
State Small Water System	Estimated Total Capital Cost < $2 million
Domestic Well	Estimated Total Capital Cost < $150,000

STEP 5: MODEL ADDITIONAL INFRASTRUCTURE/ADMIN NEEDS FOR SYSTEMS WHERE PHYSICAL CONSOLIDATION IS SELECTED BY THE MODEL

When the Cost Assessment Model indicates that physical consolidation is viable, then additional costs may be added to enhance water system sustainability and to address water quality issues, source capacity issues, and aging infrastructure. **It is important to understand that none of the additional costs will be used to analyze the modeled funding viability thresholds for physical consolidation in Step 4.**

TREATMENT COST

Receiving public water systems that are failing due to water quality issues will have centralized treatment modeled as an additional long-term solution. Due to the State Water Board's

incomplete current treatment facility data, the Cost Assessment Model will assume new treatment is needed. The Cost Assessment Model will utilize estimated source production and select Best Available Technologies (BATs) based on the system's violating analyte/s. Modeled centralized treatment will be sized to accommodate both Joining and Receiving systems' combined population. Learn more in Supplemental Appendix: Centralized Treatment Cost Estimate Methodology.[12]

ADDITIONAL SOURCE (WELL) COST

When a modeled physical consolidation project involves a Receiving community water system with a single source of water supply, then an additional cost for a backup public supply well will be estimated by the Cost Assessment Model. The cost estimate for the new public supply well incorporates the modeled needs for the total number of customers between the Receiving system and Joining system. The modeled new public supply well will only be modeled for Receiving systems that rely on groundwater. However, if the source is only surface water, then the Receiving water system will be excluded from this analysis. Learn more about how additional source needs are identified and estimated in Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology.[13]

OTHER ESSENTIAL INFRASTRUCTURE (OEI)

Many Failing and At-Risk public water systems have aging infrastructure. Upgrading and replacing them is essential to improve water quality issues and increase the overall reliability of those water systems. Other essential infrastructure (OEI) is identified based on system and location-specific information. Learn more about how OEI needs are identified and estimated in Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology.[14]

ADDITIONAL COSTS

Depending on the water system and their identified challenges, the Cost Assessment Model may add additional costs for the systems where physical consolidation is the selected modeled solution. Additional costs may include technical assistance and/or administrator assistance Learn more about how these additional needs are identified and estimated in Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology.[15]

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[12] Supplemental Appendix: Centralized Treatment Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-centralized-treatment.pdf
[13] Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-add-longterm-solutions.pdf
[14] Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-add-longterm-solutions.pdf
[15] Supplemental Appendix: Additional Long-Term Modeled Solutions Cost Estimate Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-add-longterm-solutions.pdf

STEP 6: MODEL ALTERNATIVE LONG-TERM SOLUTIONS FOR SYSTEMS WHERE PHYSICAL CONSOLIDATION IS NOT SELECTED

Systems where modeled physical consolidation does not meet the physical and/or funding viability criteria will move forward in the Cost Assessment Model to identify alternative modeled long-term solutions. The Cost Assessment Model will match identified challenges to possible long-term and short-term solutions. Learn more in the Cost Assessment Methodology Appendix.[16]

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[16] Appendix: Cost Assessment Methodology
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2024/2024costassessment-methodology.pdf

APPENDIX A: GIS METHODOLOGY

DATA SOURCES:

- North American Premium Street Map.[17]
- Service Area Boundary Layer (SABL) water49 database shapefile.[18]
- Missing Service Area Boundary Layer locational data merged with SABL layer called "SABL+"[19] (see Public Water Systems, Step 1).
- List of all community water systems and NTNC schools with SAFER Status last updated on 01/01/24.[20]
- Domestic well (DW) and state small water system (SSWS) Combined Risk Map provided by Groundwater Ambient Monitoring and Assessment Program (GAMA).[21]

PUBLIC WATER SYSTEM: CLOSEST ROUTE RECEIVING SYSTEM ANALYSIS

STEP 1: ADD MISSING SYSTEMS TO THE SERVICE AREA BOUNDARY LAYER (SABL)

1. The service area boundary of water systems is used as the primary locational reference for all water systems included in the analysis. The SABL shapefile includes most public water systems, however there are systems in the physical consolidation inventory missing from the dataset. Those missing systems are given an estimated service area to incorporate into the analysis.

2. The estimated service area starts from a single point of locational data tied to each system. These point locations can come from a variety of sources such as well locations, facility locations, or physical addresses.

3. In ArcPro, to merge two layers together, they need to be in the same layer format. The SABL layer is a polygon layer while the missing points are a point layer. To convert the missing points into polygons a 0.5-mile buffer is created around each point using the

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[17] StreetMap Premium - North America | ArcGIS Hub
https://hub.arcgis.com/content/d3c77c670f924bd189befa4af4a9ca3c/about

[18] System Area Boundary Layer (SABL) Look-up Tool (ca.gov)
https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=272351aa7db14435989647a86e6d3ad8

[19] SABL_PLUS_(ca.gov)
https://gispublic.waterboards.ca.gov/portal/home/item.html?id=0e4c019a46454725b058edd90538732a

[20] Drinking Water - SAFER Dashboard Failing and At-Risk Drinking Water Systems - Datasets - California Open Data https://data.ca.gov/dataset/safer-failing-and-at-risk-drinking-water-systems

[21] Hosted/Combined_Risk_Domestic_Wells_and_State_Small_Water_Systems (FeatureServer) (ca.gov)
https://gispublic.waterboards.ca.gov/portalserver/rest/services/Hosted/Combined_Risk_Domestic_Wells_and_State_Small_Water_Systems/FeatureServer

"Create Buffer" tool in ArcPro. This gives the water system a circular area of coverage with a 1-mile diameter.

    a. The 0.5-mile distance was chosen as an approximation to the potential service area of each point since most of the missing systems are small water systems.

    b. In previous iterations of this analysis a 1-mile buffer distance was utilized resulting in a 2-mile diameter area of coverage as the buffer would extend one mile in every direction from the center point. This was deemed too large to reasonably depict these missing systems especially when compared to other known SABL boundaries of comparable population size.

4. The SABL layer is then merged with these missing locations into a new layer that will be referred to as the "SABL+ layer" moving forward.

Figure 4: Visual comparison of the Standard SABL layer to the SABL+ layer. Note the addition of the estimated water system boundary for the missing system (see red arrow)
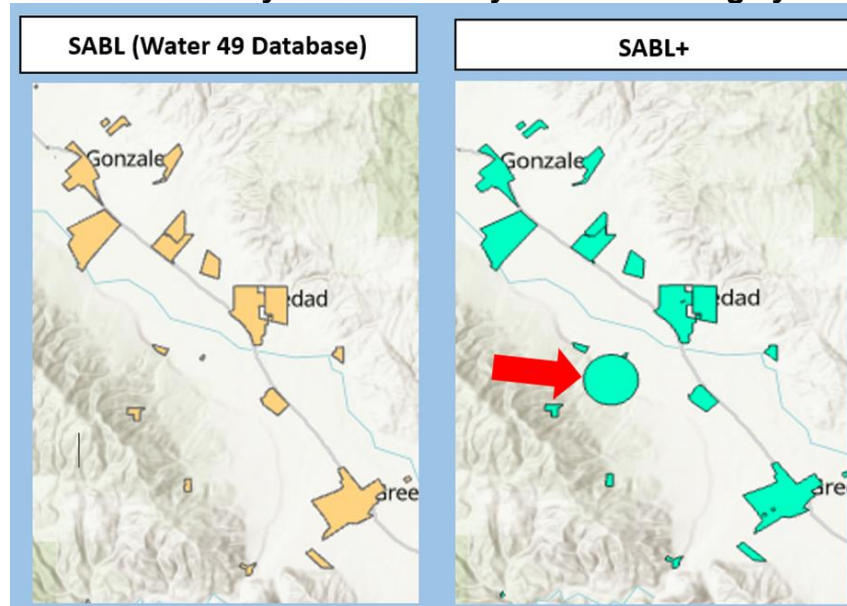
STEP 2: DEFINE RECEIVING AND JOINING SYSTEMS

1. Define Receiving and Joining systems based on the physical consolidation inventory criteria.

2. Utilize the master excel sheet of all community water systems and NTNC schools pulled from the SAFER Dashboard to determine list of possible Receiving and Joining systems using defined inventory criteria. The dataset includes the necessary datapoints needed for this: Public Water System ID (PWSID), number of service connections, and SAFER status.

3. In excel using filters, select the lists of Joining and Receiving systems.

a. Example Joining: Risk status = At-Risk and service connections < 500.

4. Select Joining systems and create a CSV. by saving the specific tab you are on as a CSV. or comma separated value file.

   a. Excel Sheet uploaded into ArcPro must be saved as Comma Separated Value files or .CSV in order to be used in analysis with the application.

5. Select Receiving systems and create a CSV. by saving the specific tab you are on as a CSV. or comma separated value file.

6. Upload into ArcPro by dragging and dropping those CSV. files into the "Table of Contents" pane.

Figure 5: "Table of Contents" pane within the standard ArcPro user interface. This pane is typically found on the left-hand side under the "Drawing Order" ribbon.
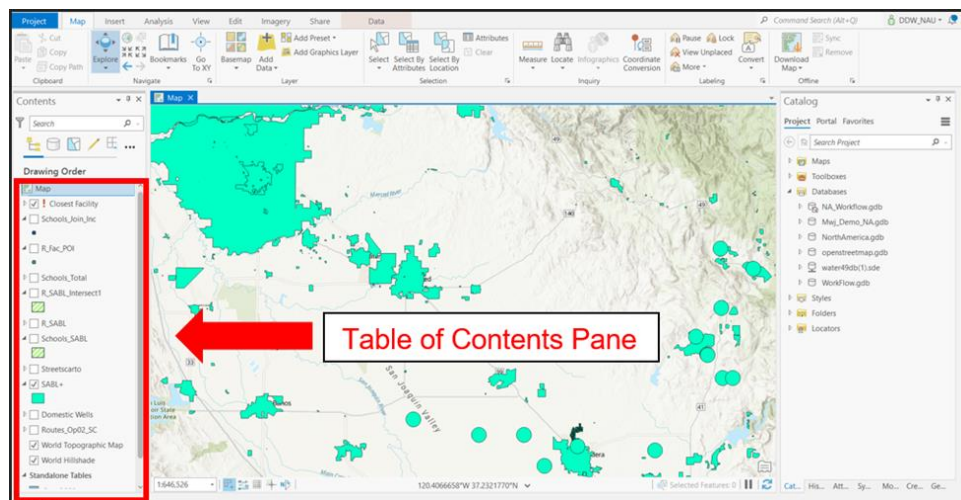
STEP 3: CREATE JOINING AND RECEIVING PRIMARY LAYERS

1. Use the "Add Join" tool to the SABL+ layer connecting the Receiving system CSV.

Figure 6: Location of the "Add Join" tool within ArcPro. Right click the selected layer then under the "Joins and Relates" pop up menu click "Add Join" to bring the "Add Join" tool menu.
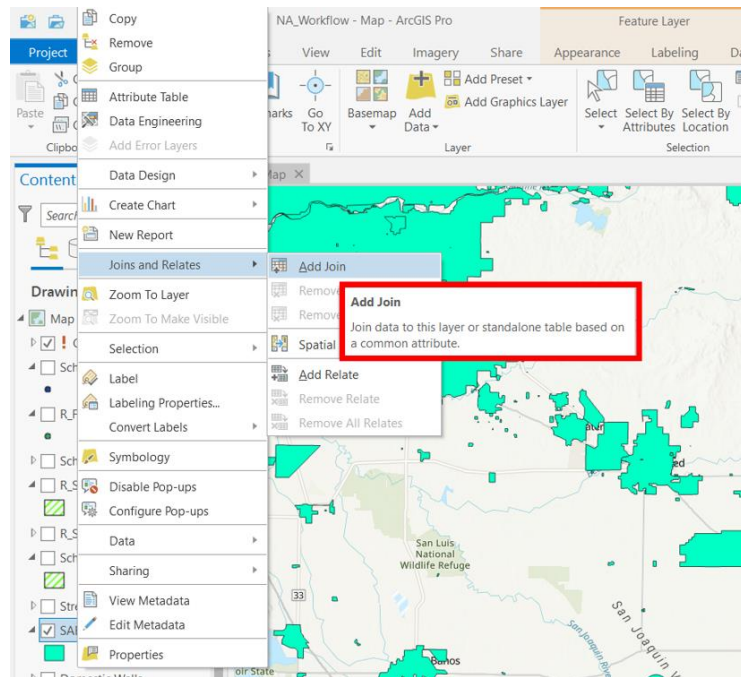
2. After adding a join from the Receiving CSV. to the SABL+ layer there should be new fields now attached to the SABL+ layer's attribute table.

3. One of these fields should be the PWSIDs from the Receiving CSV. which will be referenced as "RPWSID" in these instructions.

4. Use the "Select by Attributes" tool on the SABL+ layer and select for all records where "RWPSID = Not Null".

Figure 7: Location of the "Select by Attributes" tool within ArcPro. The tool is in the top ribbon under "Map". Here the selected feature is any record within the SABL+ layer where the PWSID of joined systems "is Not Null".
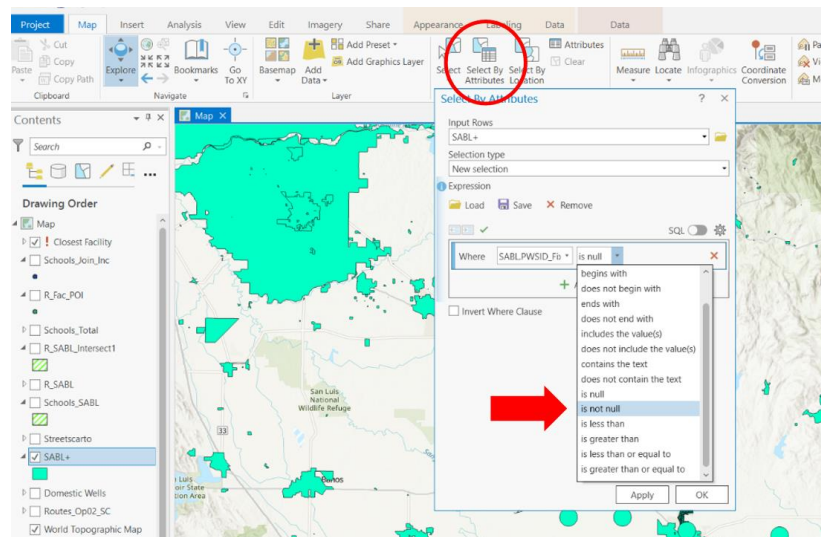
5. This should select only records where a RPWSID is available, all systems in the Receiving CSV. This creates the "Receiving_SABL" dataset.

6. Repeat steps 1 through 5 for the Joining systems CSV.

    a. The PWSIDs from this file will be referenced as "JPWSID" in these instructions. And the resulting dataset of "Joining_SABL" is created.

STEP 4: INTERSECTING JOINING AND RECEIVING SYSTEM'S SERVICE AREA BOUNDARIES

1. Use the "Intersect tool" on the "Joining_SABL" layer to intersect with the "Receiving_SABL" layer.

Figure 8: "Intersect" tool in ArcPro. The two layers "Joining_SABL" and "Receiving_SABL" layers are used as the "Input features" for the tool.
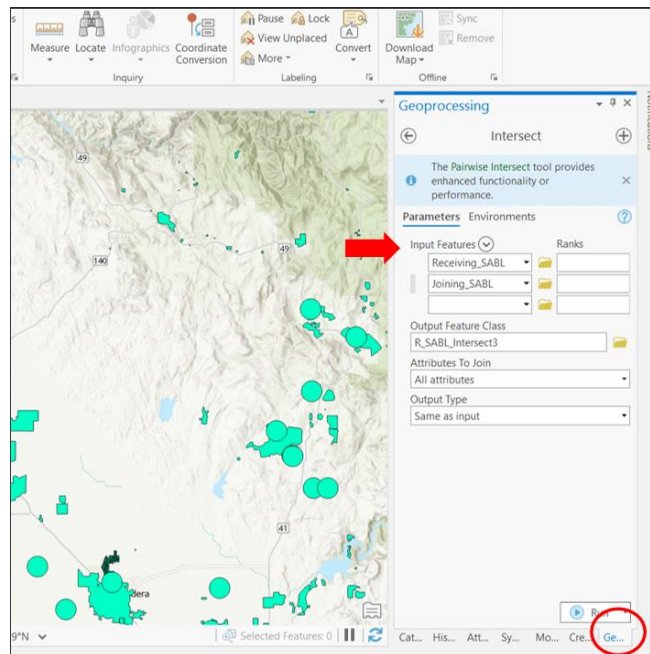
2. Use "Table to Excel" function on the new intersecting layer and save as "J_Intersect".

Figure 9: "Table to Excel" tool in ArcPro. The "J_Intersect" layer is being used as the "Input Table" or the layer that is going to be used in the tool.
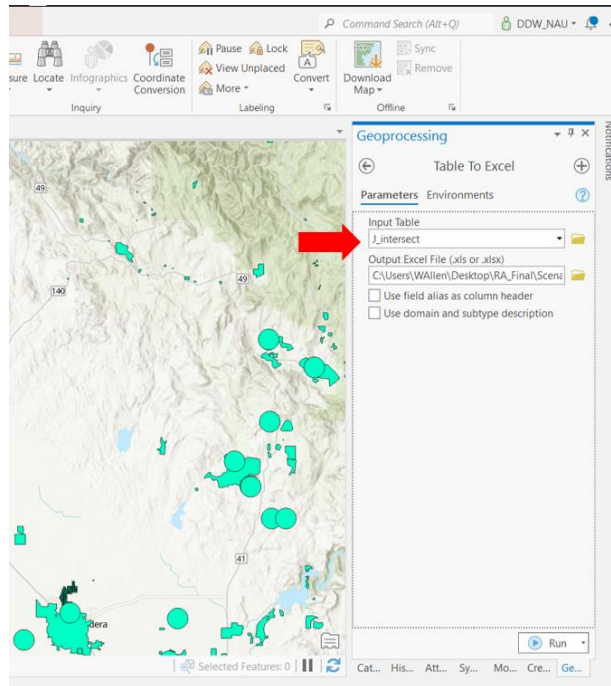
3. From the excel sheet produced; filter for the list of the unique Joining systems involved in intersecting with a Receiving system by taking all the JPWSIDs and saving them into a CSV.

4. Upload the CSV into ArcPro under the same label, "Join_Intersect".

STEP 5: REMOVE INTERSECTING JOINING SYSTEMS FROM THE ROUTE ANALYSIS INVENTORY

1. Use "add join" to the "Joining_SABL" layer to connect it to the "Join_Intersect" CSV.

2. The Joining systems that were intersecting directly with the Receiving system's boundaries will have new attributes from this join to indicate this.

3. Use the "Select by Attributes" tool on the "Joining_SABL" layer and select for all records where the joined CSV.'s new field "JPWSID = Null"

4. Produce a new layer from selection labeled "Joining_No_Int".

Figure 10: "Make Layer from Selected" tool location in ArcPro. Right click the selected layer then under the "Selection" pop up menu click "Make feature from Selected Features" (red arrow)
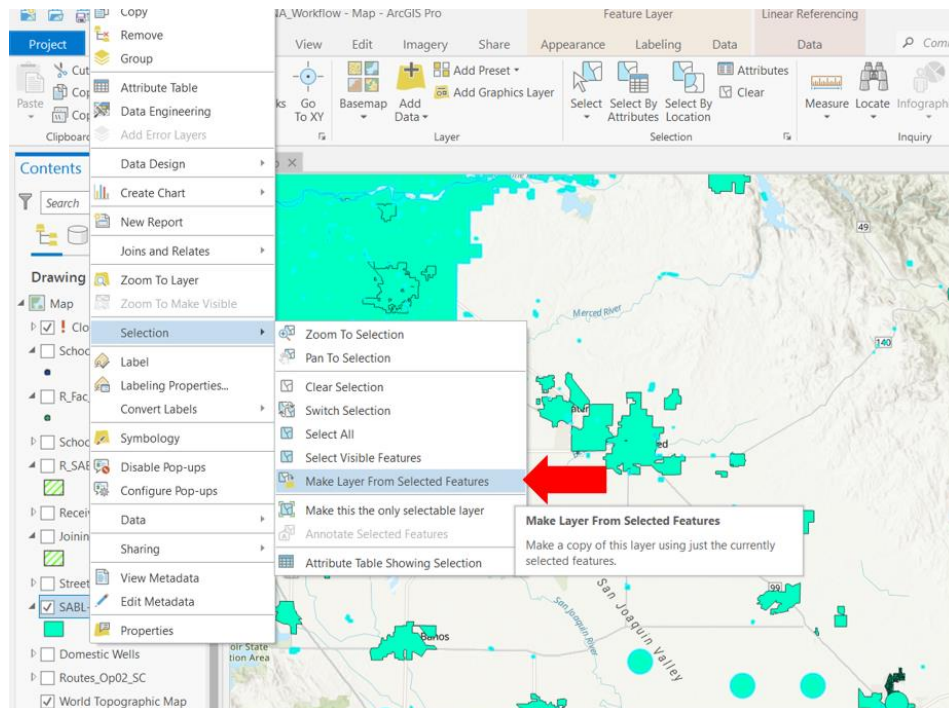
STEP 6: CREATE RECEIVING POINTS OF INTEREST LAYER FOR ROUTE ANALYSIS

1. Connect North American Geodatabase and import the multiline layer labeled as: "Streetscarto." This layer includes all digitized roads within California.

Figure 11: "Streetscarto" Layer. This layer is provided through the North American Premium Street Maps provided by ESRI
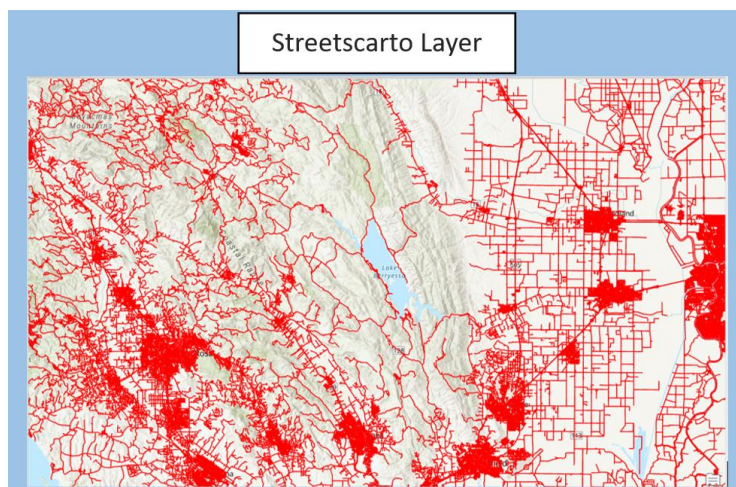
2. Intersect this layer with the "Receiving_SABL" layer and specify the output to produce 'Points'. This will give you all the point locations where the outer edge of the Receiving water system's area boundary intersects with a road.

3. Label as "Rec_POI"

Figure 12: Graphic describing how Receiving system "Points of Interest" are generated. Those points are created when a line from the streetscarto layer intersects with the outer edge of a Receiving system's service area boundary. They represent the "connection point" of a potential consolidation route from the center of a joining system to the Receiving system.
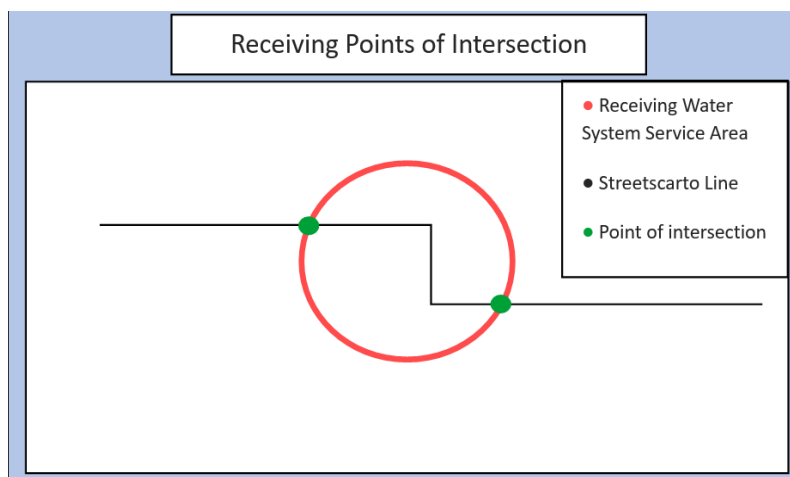
STEP 7: GENERATING JOINING SYSTEMS CENTROIDS

1. Use "Feature to Point" tool on the "Joining_No_Int" layer to convert it to a series of point locations at the center of each Joining system.

Figure 13: "Feature to Point" tool location in ArcPro. The "Joining_No_Int" layer is being used as the input feature to convert from a polygon to a single point.
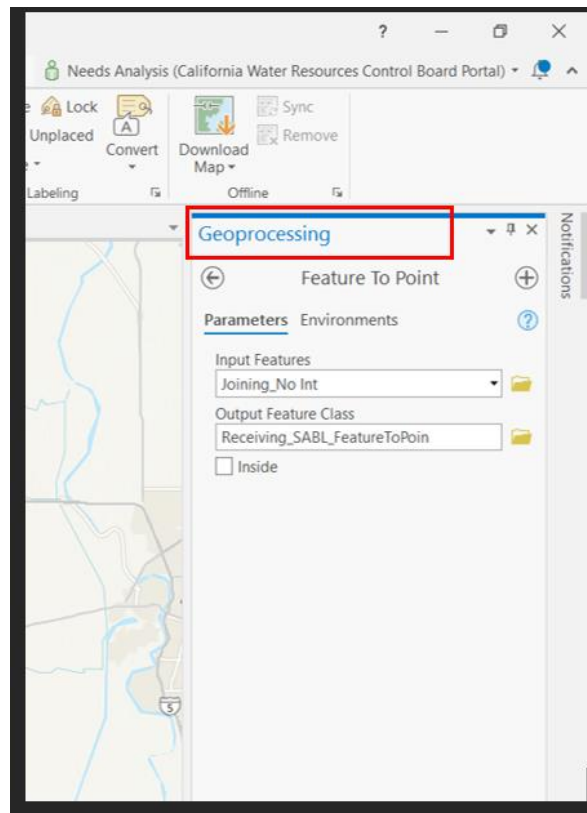
STEP 8: NETWORK ANALYSIS TOOL SET-UP

1. In the top ribbon select the tab "Analysis"

2. Then select "Network Analysis"

3. Set the data source to the "Northamerican Gdb".

4. Then select "New Network Analysis Type" for option "Closest Facility".

Figure 14: Location of the Network Analyst tool. (a) Under the analysis tab in the top ribbon (b) select the tab "Network Analyst" (C) manually select the NorthAmerican.gdb as the "Network Data Source" (d) select "Closest Facility" as the "New Network Analysis Type".
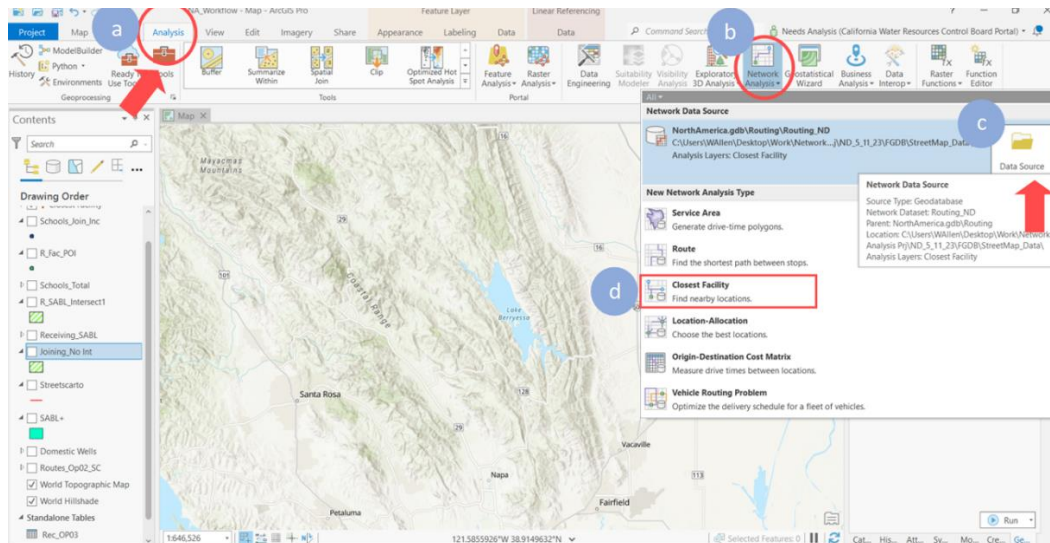
5. Set "Closest Facility Options" as:
   a. Mode: "Driving Distance"
   b. Cutoff: "3"
   c. Under "Travel Mode":
      i. Travel cost: miles
      ii. Uncheck all restrictions except "Driving an automobile."
      iii. Uncheck "Use Hierarchy"

Figure 15: Closest Facility Options
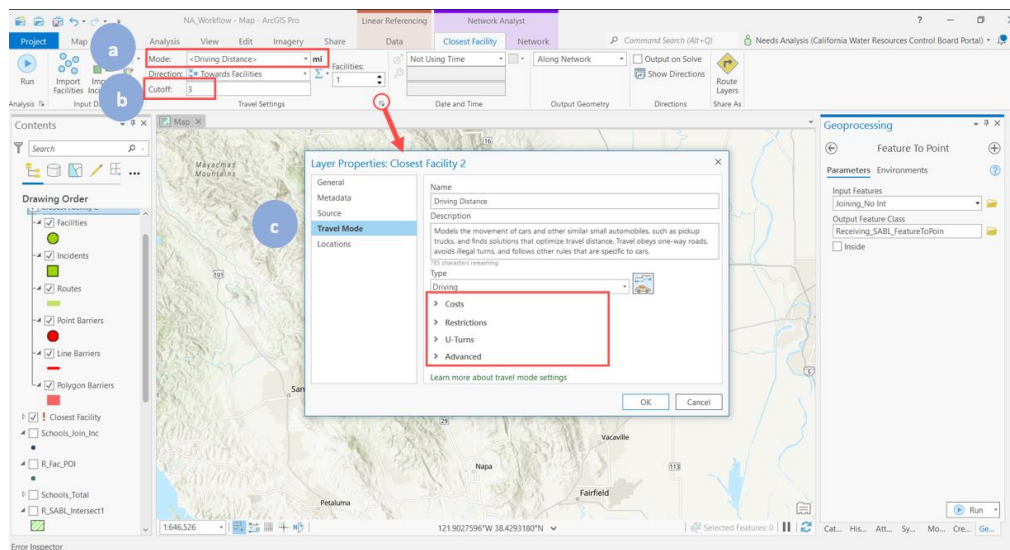
6. Use the "Import Facilities" function in as seen in Figure 16 to upload the receiving locations along the route analysis. Click on "Import Facilities" to open the "Add Locations" menu. Here select the "Rec_POI" layer for "Import Locations" and use the PWSID as the field name. Once done click ok.

Figure 16: Location of the "Import Facilities" function (red circle).
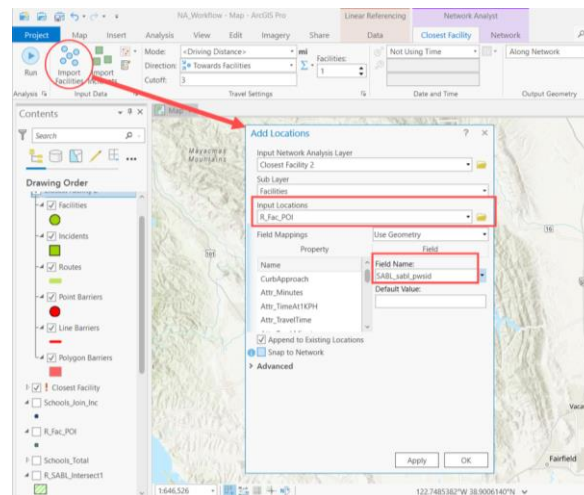
7. Use the "Import Incidents" function as seen in Figure 17 to upload the receiving locations along the route analysis. Click on "Import Incidents" to open the "Add Locations" menu. Here select the "Joining_No_Int" layer for "Import Locations" and use the PWSID as the field name. Once done click ok.

Figure 17: Location of the "Import Incidents" function (red circle).
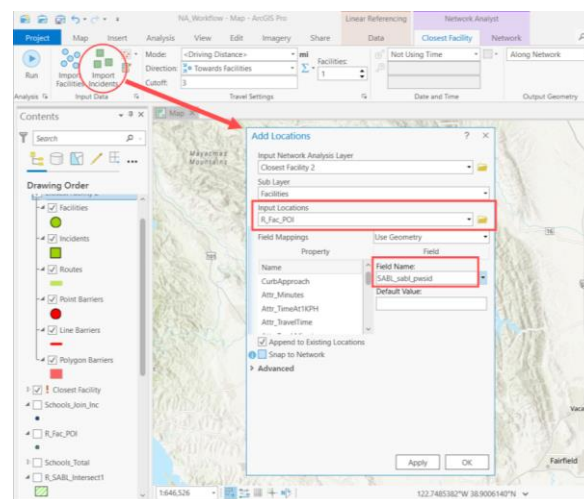
8. Hit "Run" button.

STEP 9: GENERATE EXCEL OUTPUT

1. Once the routes have been produced, use "Table to Excel" function on the "routes" layer to get an excel sheet copy of all available routes between Receiving and Joining systems.

2. Compile both routes and intersecting relationships between Joining and Receiving systems into one excel sheet that is organized by unique Joining system PWSID.

3. Data points included in final sheet include:

   a. J PWSID
   b. J Status
   c. J Population
   d. J Federal Classification
   e. J Service Connections
   f. J SAFER status
   g. J County
   h. R PWSID
   i. R Status
   j. R Population
   k. R Federal Classification
   l. R Service Connections
   m. R SAFER status
   n. R County
   o. Routing Distance (Miles)
   p. Routing Distance (Feet)

PUBLIC WATER SYSTEMS: LARGEST RECEIVING SYSTEM ANALYSIS

Selecting for the largest system is a manual process due to limitations with the network analysis tool.

The set-up for this process is the same as the closest route analysis, so begin by repeating steps 1-6 listed above:

- **Step 1**: [Add Missing Systems to the Service Area Boundary Layer (SABL)](#)

- **Step 2**: [Define Receiving and Joining Systems](#)

- **Step 3**: [Create Joining and Receiving Primary Layers](#)

- **Step 4**: [Intersecting Joining and Receiving System's Service Area Boundaries](#)

- **Step 5**: [Remove Intersecting Joining Systems from the Route Analysis Inventory](#)

- **Step 6**:

Afterwards, follow the following steps in order.

STEP 7: CREATE BUFFER INTERSECT

1. Create a 3-mile buffer around Joining Incidents using the "Create Buffers" tool. Label as "Join_Buffer"

Figure 18: Diagram of the Joining Buffer Intersect concept. A 3-mile buffer is created around the centroid of the joining system. Receiving systems are then intersected with that 3-mile buffer to see which ones are within the 3-mile distance (Receiving System A) and which are outside of the buffer, (Receiving System B).
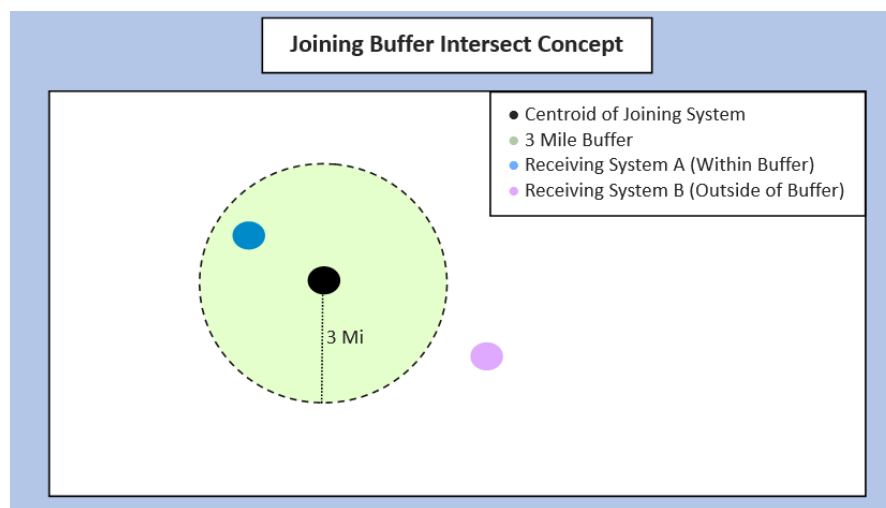
Figure 19: Create Buffers
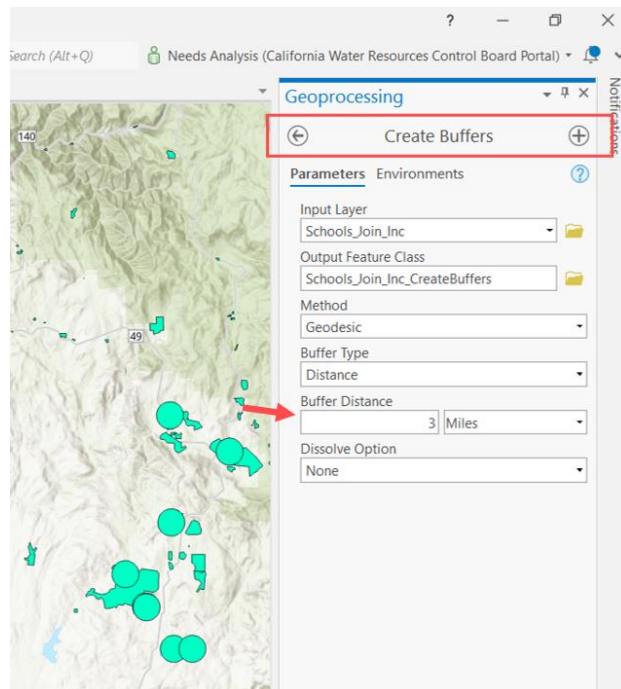
2. Intersect "Receiving_POI" with 3-mile buffer, "Join_Buffer" layer.

3. Use "Table to Excel" to export the data created from the intersect.

STEP 8: IDENTIFY LARGEST RECEIVING SYSTEM

1. In excel, for all unique Joining PWSID's manually select for one Receiving system with the most service connections.

2. Create a list of those Receiving PWSID's and save that list as CSV. and upload into ArcPro labeled, "RSC".

STEP 9: CREATING LARGEST RECEIVING SYSTEM LAYER

1. Use "Add Join" tool on the "Receiving_POI" layer to connect it to the "RSC" CSV.

2. There should be a new field added to the "Receiving_POI" layer from the "RSC" for the PWSID's involved in the "RSC" file.

3. Use "Select by Attributes" tool to select for "RSC" "PWSID = Not Null", this should select for those Receiving systems specified to have the highest service connection count that are within 3 miles of a Joining system.

4. Use create Layer from selection tool and label, "RPOI_SC".

STEP 10: CONDUCT NETWORK ANALYSIS

1. Upload "RPOI_SC". as the facilities within in the network analysis tool and the use the centroid of the Joining system after filtering out intersecting systems "Join_POI" as the incidents.

2. Use the same settings as before and hit run.

STATE SMALL WATER SYSTEM CONSOLIDATION ROUTE ANALYSIS

State small water systems were incorporated into the analysis as their own unique category. The physical locations of state small water systems were provided by County environmental health agencies and are stored in the State Water Board's SAFER Clearinghouse.[22] These locations are the latitude and longitude coordinates associated with the systems.

The overall procedure is the same as the public water system analysis; however, the following modification was incorporated:

- The routing distance used was 0.38 miles rather than 3 miles.

- Look for systems that intersect with the routes generated from the public water systems analysis.

The set-up for this process is the same as the steps for the public water systems analysis, so begin by repeating steps 1-4 listed above:

- **Step 1**: Add Missing Systems to the Service Area Boundary Layer (SABL)

- **Step 2**: Define Receiving and Joining Systems

    o This will be based on the Joining and Receiving criteria set for state small water systems as described in Table 1.

- **Step 3**: Create Joining and Receiving Primary Layers

- **Step 4**: Intersecting Joining and Receiving System's Service Area Boundaries

STEP 5: INTERSECT WITH PUBLIC WATER SYSTEM CONSOLIDATION ROUTES

There was interest in looking into state smalls and domestic wells that could be potentially picked up or connected to potential public water system consolidation lines. This type of consolidation is labeled as a "Route Intersect" as it essentially involves intersecting state small

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[22] SAFER Clearinghouse
https://wbappsrv.waterboards.ca.gov/safer/login?returnUrl=%2Fsafer-systems

water system point locations with the shapefile of the public water system routes. The process is elaborated more below:

1. Open the shapefile of the routes created for the network analysis for largest public water systems was performed.

2. Use the "Create Buffer" tool to add a 0.25-mile buffer to the Routes shapefile.

    a. The Routes shapefile is a line in a literal sense, this object is too thin to properly intersect with any potential points so to compensate a buffer is added around it.

3. Intersect the Routes Buffer with the state small water system point locations.

4. Use "Table to Excel" function on the new intersect layer.

Steps 6 & 7 are also the same for state small water systems as they are for public water systems.

- **Step 6**: [Remove Intersecting Joining Systems from the Route Analysis Inventory](#)

    o The only notable difference is to add the list of Joining state small water systems from the Route Intersect list described in step 5 above to the list of Joining to be removed from the final analysis.

- **Step 7**: [Create Receiving Points of Interest Layer for Route Analysis](#)

DOMESTIC WELLS CONSOLIDATION ROUTE ANALYSIS

Domestic wells present a unique challenge in the physical consolidation GIS analysis due to the lack of exact locational data. The State Water Board utilizes an approximation of domestic well counts and their locations based on data pulled from the Online System for Well Completion Records (OSWCR)[23] database (managed by the Department of Water Resources) which consists of "domestic" type well records, excluding those drilled prior to 1970 and only including "New/Production or Monitoring/NA" completion record types. The dataset includes a count of the total number of unique domestic well completion reports within each 1x1 mile section statewide. The layer used in this analysis is from a modified version of the OSWCR used in the 2024 Aquifer Risk Map[24].

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[23] [Well Completion Reports - Dataset - California Open Data](https://data.ca.gov/dataset/well-completion-reports)
https://data.ca.gov/dataset/well-completion-reports
[24] [2024 Aquifer Risk Map Methodology](https://www.waterboards.ca.gov/water_issues/programs/gama/docs/armmethods24.pdf)
https://www.waterboards.ca.gov/water_issues/programs/gama/docs/armmethods24.pdf#page=21&zoom=100,96,96

STEP 1: CREATE DOMESTIC WELL LAYER

1. The domestic well layer was created by converting the 1x1 mile sections into centroid points by using the "feature to point" tool in ArcPro.

2. There is a field within that layer's attribute table that gives the count of wells per point. Label this new layer, "DW_Point".

Figure 20: Domestic Well Centroid
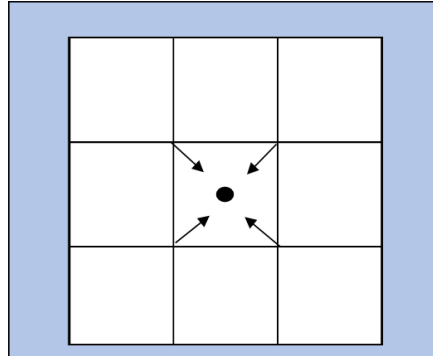
STEP 2: IDENTIFY INTERSECTING DOMESTIC WELLS

1. Intersect the "DW_Point" with the Receiving SABL layer.

2. Use "Table to Excel" tool on the new intersecting layer.

STEP 3: REMOVE INTERSECTING DOMESTIC WELLS.

1. In excel extract the list of unique Joining domestic well points then create a new CSV. and label, "DW_Points_Int"

2. In ArcPro upload the CSV and add a join to the "DW_Point" layer from the "DW_Points_Int" CSV. there should be a new field with the domestic well ID numbers (DW_ID) of the ones from the intersecting list added.

3. Use "Select by Attributes" tool on "DW_Point" and select for where "DW_ID = Not Null"

4. Create a new layer from the select records and label, "DW_No_Int."

STEP 4: CREATE BUFFER

1. Since each domestic well is an approximated location within a one-mile section, a buffer intersect is used for the consolidation distance estimate rather than a route analysis.

2. Use "Create Buffer" tool on the "DW_No_Int" and add a 0.25-mile buffer and label "DW_Buffer".

STEP 5: BUFFER INTERSECT

1. Intersect the new "DW_Buffer" with the Receiving SABL layer.

2. Use "Table to Excel" tool to export the intersect layer into excel.

STEP 6: INTERSECTING DOMESTIC WELLS WITH THE PUBLIC WATER SYSTEM PHYSICAL CONSOLIDATION ROUTE LAYER

1. Open the shapefile of the route created when the network analysis for the physical consolidation analysis for public water systems where the largest Receiving system was performed.

2. Intersect the public water system route shapefile with the original 1x1 mile section layer that represents each domestic well location.

3. Use "Table to Excel" function on the new intersect layer.

Figure 21: Route Intersect
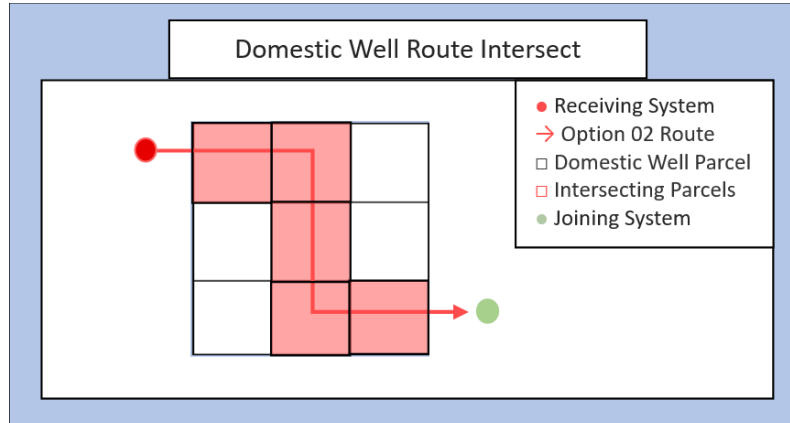
STEP 7: EXCEL COMPILATION

1. In excel compile the list of all unique domestic wells from both the direct intersect, buffer intersect, and the route intersect with their respective Receiving system.

APPENDIX B: COST ESTIMATE METHODS AND ASSUMPTIONS

COST ESTIMATE METHODOLOGY FOR EACH PHYSICAL CONSOLIDATION COMPONENT

The Cost Assessment Model utilizes a set of assumptions to develop cost estimates for physical consolidation. The original 2021 Cost Assessment model included many physical consolidation component cost assumptions which are detailed in the 2021 Drinking Water Needs Assessment.[25] In 2023 the State Water Board reviewed the original 2021 Cost Assessment Model's cost assumptions, conducted internal and external research, and proposed additions and updates to ensure the Cost Assessment Model incorporates current market values. Internal research and outreach included a thorough review of projects funded by the State Water Board and consultations with knowledgeable staff. External research and outreach consisted of a literature review, as well as consultations with water systems, venders, manufacturers, service providers, and consultants. Public feedback on the physical consolidation unit cost assumptions was solicited in July 2023 through a public webinar workshop.[26] Every effort was made to ensure cost assumptions were tailored to the state of California as much as possible.

The sections below detail the modeled physical consolidation cost assumptions used in the Cost Assessment Model. Table 5 includes a summary of the cost components.

Table 5: Physical Consolidation Capital Cost Estimate Components

Cost Component	Application	Cost Estimate ($)
Pipeline ($/Lf)	Based on modeled route.	$220/Lf
Service Line Cost ($/Project)	Included for both intersect and route Joining systems	$6,200
Connection Fees ($/Joining system service connection)	Averaging connection fees for Receiving systems for each scenario	• **Public Water Systems** = $$5,437 • **SSWS** = $2,600 • **DW** = $3,342

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[25] 2021 Drinking Water Need Assessment:
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/needs/2021_needs_assessment.pdf

[26] Draft White Paper Discussion On: Proposed Drinking Water Cost Assessment Model Assumptions on Physical Consolidation: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/docs/2023/20230714-final-cost-assessment-consolidation-white-paper.pdf.
Cost Assessment Model: Physical Consolidation Workshop Presentation:
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/docs/2023/20230714-final-cost-assessment-consolidation-workshop.pdf

Cost Component	Application	Cost Estimate ($)
Administrative Cost ($/Project)	Included for all Failing and At-Risk systems, except At-Risk Domestic wells	15% of total construction cost.
CEQA Cost ($/Project)	• Included for all Failing and At-Risk systems, except At-Risk DWs	• **Intersect** systems = $25,000 • **Route** systems = $100,000
Treatment Cost	Included for Failing Receiving systems due to water quality issues	Apply BAT[27] Capital and O&M[28] per failing analyte. (*excluded from physical consolidation funding viability determination*)
Additional Source	Included for Receiving systems with single source of water supply.	Additional cost for well if system relies on one source. (*excluded from physical consolidation funding viability determination*)
Contingency	Included for all Failing and At-Risk systems, except At-Risk DWs	20% Total cost
Inflation	Included for all systems regardless of size and type	3.1% Total cost
Planning & Construction	Included for all systems regardless of size and type	10% Total cost
Engineering Services	Included for all systems regardless of size and type	15% Total cost
Regional Multiplier	Included for all systems regardless of size and type	• Rural Counties (0%) • Urban Counties (+32%) • Suburban Counties (+30%)

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[27] Best available technology (BAT).
[28] Operations and maintenance (O&M).

Equation 1:
The total modeled consolidation capital cost for Failing and At-Risk public water systems and High-Risk state small water systems[29] = Regionally adjusted pipeline cost + Regionally adjusted service line cost + Connection fees + Administration cost + CEQA cost + 20% contingency + 10% Planning and construction + 15% Engineering services + 3.1% Inflation.

Equation 2:
The total modeled consolidation capital cost for High-Risk domestic wells (intersect and route):[30] Regionally adjusted pipeline cost + Regionally adjusted service line cost + Connection fees + 10% Planning and Construction + 15% Engineering services + 3.1% Inflation.

Equation 3:
The total modeled consolidation capital cost for High-Risk domestic wells (route intersect):[31] Regionally adjusted service line cost + Connection fees + 10% Planning and construction + 15% Engineering services + 3.1% Inflation.

Equation 4:
The total modeled consolidation capital cost for High-Risk state small water systems (route intersect):[32] Regionally adjusted service line cost + Connection fees + 10% Planning and construction + 20% contingency + 15% Engineering services + 3.1% Inflation.

PIPELINE COSTS

Pipelines are designed to convey treated water from receiving systems to Joining systems' customers by connecting to the Receiving system's existing distribution system. Pipelines are assumed to be 12-inch diameter to ensure delivery of water at adequate pressure throughout the system.

Pipeline Cost Estimate Assumptions

The Cost Assessment Model assumes $220 per linear foot for installing a pipeline to connect a Joining water system to a Receiving water system. Underlying pipeline costs assumptions are detailed below:

- Modeled Pipeline Cost by Linear Foot:

    - Material cost for 12" PVC C900[33] = $55 per linear foot.

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[29] High-Risk state small water systems that are either intersecting the service area boundary of a Receiving public water system or within a 0.38-mile route distance from a Receiving public water system.

[30] High-Risk domestic wells that are either intersecting the service area boundary of a Receiving public water system or within a 0.38-mile route distance from a Receiving public water system.

[31] High-Risk domestic wells that intersect a viable public water system's modeled physical consolidation route.

[32] High-Risk state small water systems that intersect a viable public water system's modeled physical consolidation route.

[33] C900 PVC: C900 is the American Water Works Association (AWWA) standard for cast-iron-pipe-equivalent outside diameter PVC pressure pipe and fabricated fittings covering nominal pipe sizes from 4 inches through 12

- Installation cost = $165 per linear foot.

Equation 5: Installed Pipeline Cost Estimate Formula

Pipeline Cost/Lf = Material ($55) + Installation ($165) = $220

Pipeline Distance Assumptions

The Cost Assessment Model's GIS analysis in Step 2 is used to estimate the pipeline length needed for the cost estimate (learn more in Appendix A).

Route: For Joining and Receiving systems whose location and/or service area boundaries do not intersect, the Cost Assessment Model uses the estimated distance between the two systems along an existing street from the boundary of the Receiving system to the centroid of the Joining system. For modeled physical consolidations for public water systems and state small water systems, an additional 1,000-foot buffer is added to the GIS-calculated distance to account for limitations in the GIS distance/route analysis.

Intersect: For Joining systems whose location or service area boundary intersect with a Receiving water system's service area boundary, a 1,000-foot distance is assumed for public water systems and state small water systems, and a shorter pipeline of 200 ft is used for domestic wells.

Route Intersect: For Joining state small water systems and domestic wells that intersect the public water system's modeled physical consolidation route, the Cost Assessment Model assumes no additional pipeline is needed. This assumption is made in the Cost Assessment Model because the pipeline costs for consolidating these systems are accounted for in the public water system physical consolidation route cost estimate. However, the Cost Assessment Model does include the estimated costs associated with new service lines for these systems.

Total Pipeline Cost Estimate Formula

Total pipeline cost is a function of pipeline cost per linear foot and the total estimated distance from the Joining system to the Receiving system.

Equation 6: Route System Pipeline Cost Estimate Formula

Total estimated pipeline cost (public water systems and state small water systems) = [1,000 ft Buffer + Total Estimated Distance (ft) from GIS analysis] x $220/Lf

Total estimated pipeline cost (domestic wells) = Total Estimated Distance (ft) from GIS analysis] x $220/Lf

Equation 7: Intersect System Pipeline Cost Estimate Formula

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inches. C900 pipes and fittings must comply with the Safe Drinking Water Act requirements, meaning for potable water transmission and distribution. The C900 standard does not include injection-molded PVC fittings.

Total pipeline cost (public water systems and state small water systems) = 1,000 ft x $220/Lf

Total pipeline cost (domestic wells) = 200 ft x $220/Lf

SERVICE LINE COST

Service lines are water service laterals running from the branched main in the water system's distribution system into the customer's property where the meter is installed. Service lines vary in length but are usually longer in rural or suburban areas since most customers are set further back from the road.

Service Line Cost Estimate Assumptions

Service line costs can vary, depending on length, location, material, and many other installation factors. For the purposes of the Cost Assessment Model, service line costs are assumed to be $6,200 per service connection.[34] Underlying service line costs assumptions are detailed below:

Equation 8: Individual Service Line Cost Estimate

Individual Service Line Cost/Lf = Material Cost ($3.30/Lf) + Installation ($100/Lf)

Equation 5: Service Line Length Assumption

Lateral Length = 60 ft[35]

Equation 6: Service Line Total Estimated Cost

Total Service Line Cost/Lf = (Material Cost x Lateral Length) + (Installation Cost x Lateral Length) = (60 ft x $3.30) + ($100 x 60 ft) = $6,200

Total Service Line Cost/Lf = $6,200 x (count of Joining system service connections)

CONNECTION FEES

Connection fees are one-time charges that Receiving systems typically issue for new customers being connected to their water system or existing customers wishing to increase usage. It is important to estimate a certain level of capacity required to serve both base and peak demand periods. The connection fee equates to the reservation of system capacity to serve that new connection. Connection fees can vary dramatically from system to system across the State. The State Water Board collects information about new connection fees in the electronic Annual Report (eAR) which water systems are required to complete.

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[34] Based on internal discussion with expert staff, for public water systems with 0 or missing number service connections, the Cost Assessment Model creates a surrogate connection number by dividing the population served by 3.3 and rounding the number to the highest integer. For missing service connections for state small water systems, the Cost Assessment Model assumes 6 connections, and each domestic well is considered a service connection.

[35] Based on local plumber recommendations in a Sacramento-suburban area.

Connection Fees Cost Estimate Assumptions

The Cost Assessment Model utilizes the average connection fees for the identified Receiving systems selected by through Step 1 and Step 2 of the physical consolidation analysis. The Cost Assessment Model develops average connection fees for the following:

- Public water systems
- State small water systems
- Domestic wells

The steps below summarize the methodology that State Water Board utilized to update the connection fee cost assumption in the Model:

Equation 7: Develop Average Connection Fees

1. Consolidated Joining public water system connection fees = Average connection fees for their potential Receiving public water systems.

2. Consolidated Joining small water system connection fees = Average connection fees for their potential Receiving public water systems.

3. Consolidated Joining domestic well connection fees = Average connection fees for their potential Receiving public water systems.

For the 2023 Cost Assessment, the average connection fees per systems type were:

- Public water systems = $4,762
- State small water systems = $3,411
- Domestic wells = $3,181

Equation 8: Determine Connection Fees for Each Joining System

Connection fees cost ($) = (Average Receiving system's connection fees) x (count of Joining system's service connections)

ADMINISTRATION

Administration costs are fees charged by a consultant related to providing eligible supportive services to the project. The eligible expenses are usually defined for each budget line item but are mainly comprised of legal fees, project management, and inspections. Administrative fees, such as Local Agency Formation Commission (LAFCo) or California Public Utilities Commission (CPUC) fees, have not been included. Additional data would need to be collected to determine how these costs can be incorporated into future iterations of the Cost Assessment Model.

Administrative Fees Cost Estimate Assumptions

Since administration costs are typically driven by the size of project and time spent on each eligible item, the Cost Assessment Model includes an estimated administration cost that varies depending on the total construction cost. The Cost Assessment Model assumes estimated

administrative costs are 15% of the total physical consolidation pipeline capital cost estimate. Underlying costs assumptions are detailed below:

Equation 9: Calculate Construction Cost

Pipeline Construction Cost = Regionally Adjusted Pipeline Cost + Regionally Adjusted Service Lines Cost

Equation 10: Calculate Project Administration Fees

Administration Fees = 0.15 x (Pipeline Construction Cost)

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) FEES

CEQA Plus[36],[37] fees include an initial study to determine whether the project may have a significant adverse effect on the surrounding environment. Also, an additional cost is typically included to cover the preparation of an Environmental Impact Report (EIR), if adverse effects are identified. However, most consolidation projects apply revisions in the project plans or proposals to avoid or mitigate the effects to a safer extent where all adverse impacts are eliminated, then, a Mitigated Negative Declaration (MND) can be adopted and filed.

CEQA Fees Cost Estimate Assumptions

CEQA costs can vary depending on whether the project may have a significant adverse effect on the environment and the requirements associated with alleviating any potential negative effects. CEQA costs are usually proportional to the distance between Receiving and Joining systems. As such, when two systems are adjacent and their boundaries are intersecting, there is usually less anticipated disruption and subsequently less damage to the environment. However, when systems are relatively far apart and can only be physically consolidated through a route, it is expected to have a substantial change in the physical conditions within the area affected by the project, mainly land, and subsequently an increase in needed mitigation measures. Therefore, the Cost Assessment Model utilizes different CEQA cost estimates for modeled routes and intersect physical consolidations. Underlying costs assumptions are detailed below:

Equation 11: CEQA For Intersect Consolidation

CEQA Fees = $25,000[38]

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[36] CEQA Plus: The State Water Board elected to develop its own State Environmental Review Process which utilizes the environmental documents developed under the CEQA as well as documents prepared for compliance with specified federal environmental laws and regulations (also referred to as federal crosscutters) for its "NEPA-like" process (which is referred to as "CEQA Plus"). The CEQA Plus process complies with the required elements outlined in 40 C.F.R. section 35.3140(b) and refers to the documents prepared for the CEQA as well as the supplemental information provided for compliance with the applicable federal cross cutters authorities: https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/docs/policy0513/appendix_i_envguide.pdf.

[37] Governor's Office of Planning and Research, CEQA Technical Advice Series https://opr.ca.gov/docs/MND_Publication_2004.pdf

[38] Cost includes Initial Study Cost and Fees + MND Study Cost and Fees.

Equation 12: CEQA For Route Consolidation

CEQA Fees = $100,000[39]

Equation 13: CEQA For Route Intersect Consolidation

CEQA Fees = $0[40]

PHYSICAL CONSOLIDATION COST ADJUSTMENTS

Inflation

Due to increases in the price of construction materials, and on-going supply chain issues stemming from the COVID-19 pandemic, the Cost Assessment Model adjusts the modeled capital physical consolidation costs with a 3.1%[41] inflation rate multiplier where appropriate. This multiplier is a California-specific inflation rate multiplier based on the California Department of Finance's[42] Urban Consumer Price Index (CPI-U).[43]

Regional Adjustments

Pipeline and service line costs, especially installation, vary greatly depending on the setting, and prices can dramatically increase with a high cost of living and for lines that are difficult to access. An installation through farmland will be much less than an urban environment with pavement, traffic control, limited hours, and conflicting utilities.[44] The Cost Assessment Model adjusts pipeline and service line cost estimates for regional cost variance using the RSMeans City Cost Index (CCI).[45] The CCI is used to compare and adjust costs between locations. The California CCI shown in Table 6 are applied based on each system's location.

Table 6: RSMean City Cost index for Locational Cost Estimating

Location	RSMeans CCI	Percent Adjustment
Rural	+3.0	0%
Urban	+3.97	+32%
Suburban	+3.89	+30%

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[39] Cost Includes Initial Study Cost and Fees + EIR Cost and Fees

[40] For Joining state small water systems and domestic wells that intersect a public water system's modeled physical consolidation route, the Cost Assessment Model assumes no CEQA is needed. This assumption is made in the Cost Assessment Model because the pipeline and associated CEQA costs for consolidating these systems are accounted for in the public water system physical consolidation route cost estimate.

[41] Inflation is forested between April 2023 to April 2024.

[42] Economic Forecasts, U.S. and California | Department of Finance - https://dof.ca.gov/forecasting/economics/economic-forecasts-u-s-and-california/

[43] The inflation rate can be calculated month-to-month using a publicly available resource. Consumer Price Index Forcase- Annual and Monthly: https://dof.ca.gov/forecasting/economics/economic-forecasts-u-s-and-california/.

[44] American Water Works Association, Life Cycle Cost Analysis for Pipelines: https://american-usa.com/news/wp-content/uploads/AWWA-WIC-St.-Louis-.pdf

[45] RSMeans City Cost Index: https://www.rsmeans.com/rsmeans-city-cost-index

The categorization of counties by the generalized location for applying the CCI is shown in Table 7.

Table 7: California Counties Categorized by Generalized Location

Location	Counties
Rural	Alpine, Amador, Butte, Calaveras, Colusa, Del Norte, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Madera, Mariposa, Mendocino, Merced, Modoc, Mono, Nevada, Placer, Plumas, San Joaquin, Shasta, Sierra, Siskiyou, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Yolo, Yuba
Suburban	Alameda, Contra Costa, El Dorado, Marin, Monterey, Napa, Orange, San Benito, San Bernardino, San Luis Obispo, Santa Barbara, Santa Cruz, Solano, Sonoma
Urban	Los Angeles, Riverside, Sacramento, San Diego, San Francisco, San Mateo, Santa Clara, Ventura

Contingency

Contingency is typically included in construction budgets to account for additional and unexpected costs due to natural, staffing, or funding issues. The Cost Assessment Model assumes estimated contingency at 20% of the total cost[46] to account for costs fluctuations.

Planning and Construction

The Cost Assessment Modal includes a planning and construction multiplier that accounts for costs associated with the planning, management, and execution of construction projects. These expenses are essential in maintaining an organized timeline of events, allocating staffing for the project, and determining the necessary materials and equipment needed. Proper planning can also help ensure the overall quality of the project meets the client's expectations. The Cost Assessment Model applies a 10% planning and construction multiplier to the total cost.[47]

Engineering Services

The Cost Assessment Modal includes an engineering services multiplier that accounts for costs associated with the preparation of a preliminary engineering report, construction, and post construction phase services, as well as preliminary and final design services. The Cost Assessment Model applies a 15% engineering services multiplier to the total estimated capital cost.[48]

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[46] Total physical consolidation capital cost incudes regionally adjusted pipeline cost, regionally adjusted service line cost, connection fees, administration cost, and CEQA.
[47] Total physical consolidation capital cost incudes regionally adjusted pipeline cost, regionally adjusted service line cost, connection fees, administration cost, and CEQA.
[48] Total estimated physical consolidation capital cost incudes regionally adjusted pipeline cost, regionally adjusted service line cost, connection fees, administration cost, and CEQA.