9 TRAFFIC MANAGEMENT STRATEGY

This section discusses the suggested traffic control and management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy include:

- Personnel with the capabilities of performing the planned control functions of traffic guides (preferably, not necessarily, law enforcement officers).
- Traffic Control Devices to assist these personnel in the performance of their tasks. These devices should comply with the guidance of the Manual of Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA) of the U.S.D.O.T. All state and most county transportation agencies have access to the MUTCD, which is available on-line: http://mutcd.fhwa.dot.gov which provides access to the official PDF version.
- A plan that defines all locations, provides necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that safely expedite travel out of the EPZ.
2. Discourage traffic movements that move evacuating vehicles in a direction which takes them significantly closer to the power plant, or which interferes with the efficient flow of other evacuees.

We employ the terms "facilitate" and "discourage" rather than "enforce" and "prohibit" to indicate the need for flexibility in performing the traffic control function. There are always legitimate reasons for a driver to prefer a direction other than that indicated. For example:

- A driver may be traveling home from work or from another location, to join other family members prior to evacuating.
- An evacuating driver may be travelling to pick up a relative, or other evacuees.
- The driver may be an emergency worker en route to perform an important activity.

The implementation of a plan must also be flexible enough for the application of sound judgment by the traffic guide.

The traffic management plan is the outcome of the following process:

1. The existing TCPs and ACPs identified by the offsite agencies in their existing emergency plans serve as the basis of the traffic management plan, as per NUREG/CR-7002.
2. Computer analysis of the evacuation traffic flow environment.

   This analysis identifies the best routing and those critical intersections that experience pronounced congestion. Any critical intersections that are not identified in the existing offsite plans are suggested as additional TCPs and ACPs
3. The existing TCP and ACP, and how they were applied in the ETE study, is presented in Appendix G.

4. Prioritization of TCPs and ACPs.

   Application of traffic and access control at some TCPs and ACPs will have a more pronounced influence on expediting traffic movements than at other TCPs and ACPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located far from the power plant. These priorities should be assigned by state/county emergency management representatives and by law enforcement personnel.

The use of Intelligent Transportation Systems (ITS) technologies could reduce manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) could be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. DMS could also be placed outside of the EPZ to warn motorists to avoid using routes that may conflict with the flow of evacuees away from the power plant. Highway Advisory Radio (HAR) could be used to broadcast information to evacuees en route through their vehicle stereo systems. Automated Traveler Information Systems (ATIS) could also be used to provide evacuees with information. Internet websites could provide traffic and evacuation route information before the evacuee begins his trip, while on board navigation systems (GPS units), cell phones, and pagers could be used to provide information en route. These are only several examples of how ITS technologies could benefit the evacuation process. Consideration could be given that ITS technologies be used to facilitate the evacuation process, and any additional signage placed should consider evacuation needs.

The ETE analysis treated all controlled intersections that are existing TCP and ACP locations in the offsite agency plans as being controlled by actuated signals. No additional TCPs or ACPs are identified as a result of this study.

Chapters 2N and 5G, and Part 6 of the 2009 MUTCD are particularly relevant and could be reviewed during emergency response training.

The ETE calculations reflect the assumption that all "external-external" trips are interdicted and diverted after 2 hours have elapsed from the ATE.

All transit vehicles and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning ACPs and TCPs.

Study Assumptions 5 and 6 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

10 EVACUATION ROUTES

Evacuation routes are comprised of two distinct components:

- Routing from a sub-area being evacuated to the boundary of the evacuation region and thence out of the EPZ.
- Routing of transit-dependent evacuees from the EPZ boundary to reception centers.

Evacuees will select routes within the EPZ in such a way as to minimize their exposure to risk. This expectation is met by the DYNEV II model routing traffic away from the location of the plant, to the extent practicable. The DTRAD model satisfies this behavior by routing traffic so as to balance traffic demand relative to the available highway capacity to the extent possible. See Appendices B through D for further discussion.

The routing of transit-dependent evacuees from the EPZ boundary to reception centers is designed to minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary.

Figure 10-1 present maps showing the general population and school reception centers for evacuees. The major evacuation routes for the EPZ are presented in Figure 10-2.

Due to concerns with reception center capacity, evacuees were not routed across state borders, including:

- No traffic flow across the Newell Toll Bridge between Ohio and West Virginia
- No traffic flow on Ohio State Route 39 and Pennsylvania State Route 68 across the state borders
- No traffic flow on Ohio State Route 154 and Pennsylvania State Route 251 across the state borders
- No traffic flow along US Route 30 between Pennsylvania and West Virginia

It is assumed that all school evacuees will be taken to the appropriate host school and subsequently picked up by parents or guardians. Transit-dependent evacuees are transported to the nearest reception center for each county. This study does not consider the transport of evacuees from reception centers to congregate care centers, if the counties do make the decision to relocate evacuees.

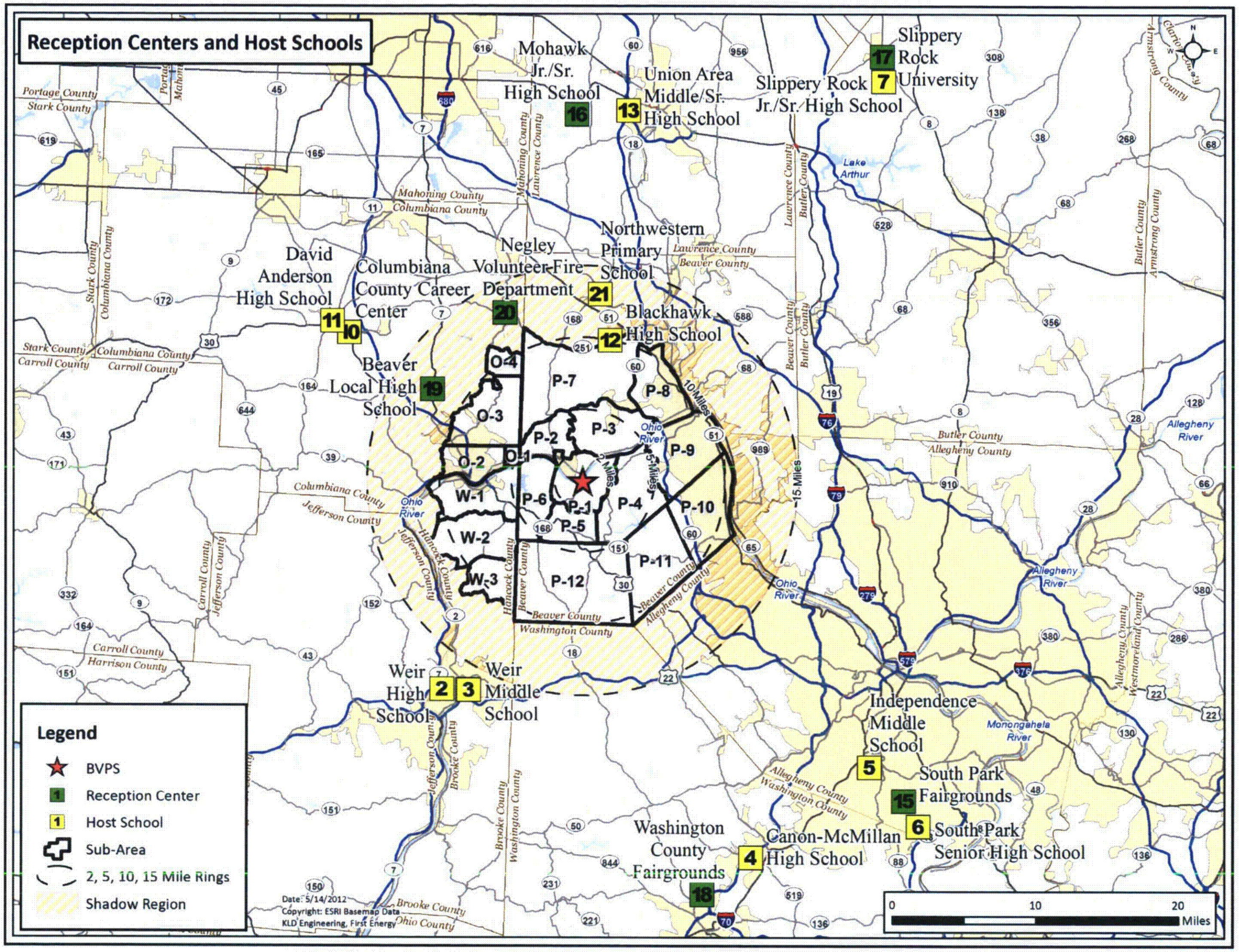


Figure 10-1. General Population Reception Centers and Host Schools

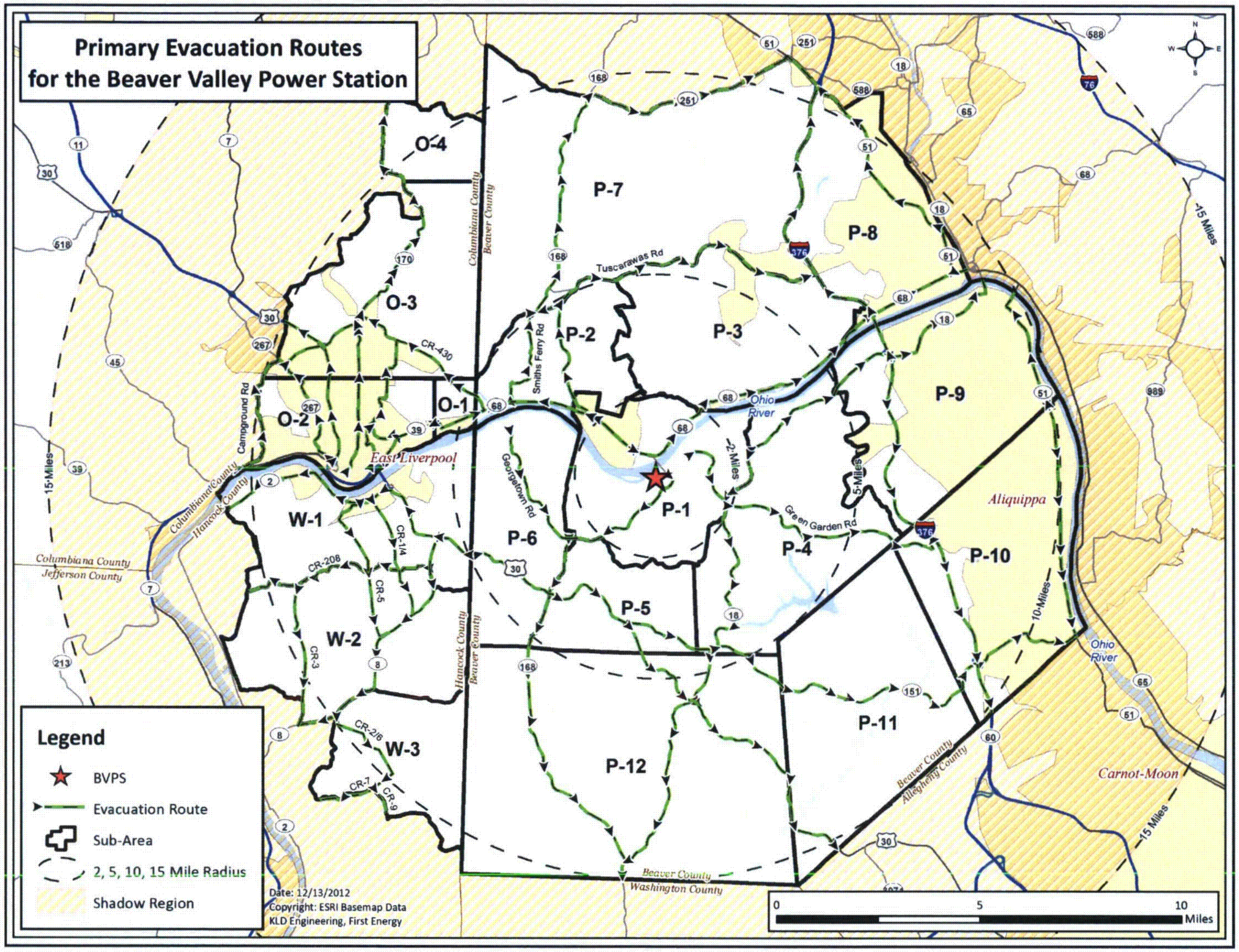


Figure 10-2. Evacuation Route Map

11 SURVEILLANCE OF EVACUATION OPERATIONS

There is a need for surveillance of traffic operations during the evacuation. There is also a need to clear any blockage of roadways arising from accidents or vehicle disablement. Surveillance can take several forms.

1. Traffic control personnel, located at Traffic Control and Access Control points, provide fixed-point surveillance.
2. Ground patrols may be undertaken along well-defined paths to ensure coverage of those highways that serve as major evacuation routes.
3. Aerial surveillance of evacuation operations may also be conducted using helicopter or fixed-wing aircraft, if available.
4. Cellular phone calls (if cellular coverage exists) from motorists may also provide direct field reports of road blockages.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. It is the responsibility of the counties to support an emergency response system that can receive messages from the field and be in a position to respond to any reported problems in a timely manner. This coverage should quickly identify, and expedite the response to any blockage caused by a disabled vehicle.

Tow Vehicles

In a low-speed traffic environment, any vehicle disablement is likely to arise due to a low-speed collision, mechanical failure or the exhaustion of its fuel supply. In any case, the disabled vehicle can be pushed onto the shoulder, thereby restoring traffic flow. Past experience in other emergencies indicates that evacuees who are leaving an area often perform activities such as pushing a disabled vehicle to the side of the road without prompting.

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Consideration should be given that tow trucks with a supply of gasoline be deployed at strategic locations within, or just outside, the EPZ. These locations should be selected so that:

- They permit access to key, heavily loaded, evacuation routes.
- Responding tow trucks would most likely travel counter-flow relative to evacuating traffic.

Consideration should also be given that the state and local emergency management agencies encourage gas stations to remain open during the evacuation.

12 CONFIRMATION TIME

It is necessary to confirm that the evacuation process is effective in the sense that the public is complying with the Advisory to Evacuate. Appendix H, section 2.9, of the Hancock County Radiological Emergency Preparedness Plan, indicates the following regarding confirmation of evacuation:

> This involves a one-time effort to drive through the affected areas at a moderate speed and report the location of residences which have not been evacuated. The County EOC will dispatch teams to these locations to verify evacuation and/or provide relocation assistance.

Section II, Part J, of the Columbiana County Radiological Emergency Preparedness Plan, indicates the following regarding confirmation of evacuation:

> Upon receipt of notification, Ohio residents are to place a previously provided "I Have Been Notified" sign in a front window or doorway. As an alternative, or backup, a white cloth may be tied to a door handle. Fire departments will drive assigned routes or territories and look for confirmation sign.

Both county methods would require additional manpower. In Hancock County, teams would be dispatched to affected residential areas to observe whether or not homes are vacant. There are approximately 200 roadway miles in the Hancock County portion of the EPZ. Assuming each person, on a 10 person team, would travel at 20 mph down each road, confirmation would take one hour per person. In the Columbiana County portion of the EPZ, fire departments would be dispatched to affected residential areas to observe whether households received notification of evacuation. There are approximately 300 roadway miles in the Hancock County portion of the EPZ. Making an assumption that 10 firefighters would be assigned to this task, each traveling at 20 mph down each road, confirmation would take 1 ½ hours per person.

Should there be insufficient manpower to confirm evacuation using either of the methods discussed above, the following alternative or complementary approach is suggested.

The suggested procedure employs a stratified random sample and a telephone survey. The size of the sample is dependent on the expected number of households that do not comply with the Advisory to Evacuate. We believe it is reasonable to assume, for the purpose of estimating sample size that at least 80 percent of the population within the EPZ will comply with the Advisory to Evacuate. On this basis, an analysis could be undertaken (see Table 12-1) to yield an estimated sample size of approximately 300.

The confirmation process should start at about 2½ hours after the Advisory to Evacuate, which is when 90 percent of evacuees have completed their mobilization activities (see Figure 5-4). At this time, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Table 12-1, approximately 7½ person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of sub-areas), then the confirmation process will extend over a time frame of about 75 minutes. Thus, the confirmation should be completed well before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the evacuation region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment or other technologies (e.g., reverse 911 or equivalent) can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

If this method is indeed used by the county, consideration should be given to maintain a list of telephone numbers within the EPZ in the EOC at all times. Such a list could be purchased from vendors and should be periodically updated. As indicated above, the confirmation process should not begin until 2½ hours after the Advisory to Evacuate, to ensure that households have had enough time to mobilize. This 2½-hour timeframe will enable telephone operators to arrive at their workplace, obtain a call list and prepare to make the necessary phone calls.

Should the number of telephone responses (i.e., people still at home) exceed 20 percent, then the telephone survey should be repeated after an hour's interval until the confirmation process is completed.

Table 12-1. Estimated Number of Telephone Calls Required for Confirmation of Evacuation

<u>Problem Definition</u>

Estimate number of phone calls, n, needed to ascertain the proportion, F of households that have not evacuated.

<u>Reference:</u> Burstein, H., <u>Attribute Sampling</u>, McGraw Hill, 1971

<u>Given:</u>

- No. of households plus other facilities, N, within the EPZ (est.) = 47,500
- Est. proportion, F, of households that will not evacuate = 0.20
- Allowable error margin, e: 0.05
- Confidence level, α: 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

$$p = F + e = 0.25; \quad q = 1 - p = 0.75$$

$$n = \frac{A^2pq + e}{e^2} = 308$$

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 306$$

Thus, some 300 telephone calls will confirm that approximately 20 percent of the population has not evacuated. If only 10 percent of the population does not comply with the Advisory to Evacuate, then the required sample size, n_F = 215.

<u>Est. Person Hours to complete 300 telephone calls</u>

Assume:

- Time to dial using touch tone (random selection of listed numbers): 30 seconds
- Time for 6 rings (no answer): 36 seconds
- Time for 4 rings plus short conversation: 60 sec.
- Interval between calls: 20 sec.

Person Hours:

$$\frac{300[30 + 0.8(36) + 0.2(60) + 20]}{3600} = 7.6$$

APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

Table A-1. Glossary of Traffic Engineering Terms

Term	Definition
Analysis Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Link	A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics.
Measures of Effectiveness	Statistics describing traffic operations on a roadway network.
Node	A network node generally represents an intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link.
Origin	A location attached to a network link, within the EPZ or Shadow Region, where trips are generated at a specified rate in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations.
Prevailing Roadway and Traffic Conditions	Relates to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.).
Service Rate	Maximum rate at which vehicles, executing a specific turn maneuver, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps) or vehicles per hour (vph).
Service Volume	Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service (The Service Volume at the upper bound of Level of Service, E, equals Capacity). Service Volume is usually expressed as vehicles per hour (vph).
Signal Cycle Length	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. A signal phase is comprised of a sequence of signal intervals, usually green, yellow, red.

Term	Definition
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds.
Traffic (Trip) Assignment	A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time.
Traffic Density	The number of vehicles that occupy one lane of a roadway section of specified length at a point in time, expressed as vehicles per mile (vpm).
Traffic (Trip) Distribution	A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes.
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness.
Traffic Volume	The number of vehicles that pass over a section of roadway in one direction, expressed in vehicles per hour (vph). Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail, pedestrian and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vehicles per hour (vph) or in vehicles.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

DTRAD: Dynamic Traffic Assignment and Distribution Model

B. DYNAMIC TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

This section describes the integrated dynamic trip assignment and distribution model named DTRAD (Dynamic Traffic Assignment and Distribution) that is expressly designed for use in analyzing evacuation scenarios. DTRAD employs logit-based path-choice principles and is one of the models of the DYNEV II System. The DTRAD module implements path-based *Dynamic Traffic Assignment* (DTA) so that time dependent Origin-Destination (OD) trips are "assigned" to routes over the network based on prevailing traffic conditions.

To apply the DYNEV II System, the analyst must specify the highway network, link capacity information, the time-varying volume of traffic generated at all origin centroids and, optionally, a set of accessible candidate destination nodes on the periphery of the EPZ for selected origins. DTRAD calculates the optimal dynamic trip distribution (i.e., trip destinations) and the optimal dynamic trip assignment (i.e., trip routing) of the traffic generated at each origin node traveling to its set of candidate destination nodes, so as to minimize evacuee travel "cost."

Overview of Integrated Distribution and Assignment Model

The underlying premise is that the selection of destinations and routes is intrinsically coupled in an evacuation scenario. That is, people in vehicles seek to travel out of an area of potential risk as rapidly as possible by selecting the "best" routes. The model is designed to identify these "best" routes in a manner that realistically distributes vehicles from origins to destinations and routes them over the highway network, in a consistent and optimal manner, reflecting evacuee behavior.

For each origin, a set of "candidate destination nodes" is selected by the software logic and by the analyst to reflect the desire by evacuees to travel away from the power plant and to access major highways. The specific destination nodes within this set that are selected by travelers and the selection of the connecting paths of travel, are both determined by DTRAD. This determination is made by a logit-based path choice model in DTRAD, so as to minimize the trip "cost," as discussed later.

The traffic loading on the network and the consequent operational traffic environment of the network (density, speed, throughput on each link) vary over time as the evacuation takes place. The DTRAD model, which is interfaced with the DYNEV simulation model, executes a succession of "sessions" wherein it computes the optimal routing and selection of destination nodes for the conditions that exist at that time.

Interfacing the DYNEV Simulation Model with DTRAD

The DYNEV II system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. An algorithm was developed to support the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next. Another algorithm executes a "mapping" from the specified "geometric" network (link-node analysis network) that represents the physical highway system, to a "path" network that represents the vehicle [turn] movements. DTRAD computations are performed on the "path" network: DYNEV simulation model, on the "geometric" network.

DTRAD Description

DTRAD is the DTA module for the DYNEV II System.

When the road network under study is large, multiple routing options are usually available between trip origins and destinations. The problem of loading traffic demands and propagating them over the network links is called Network Loading and is addressed by DYNEV II using macroscopic traffic simulation modeling. Traffic assignment deals with computing the distribution of the traffic over the road network for given O-D demands and is a model of the route choice of the drivers. Travel demand changes significantly over time, and the road network may have time dependent characteristics, e.g., time-varying signal timing or reduced road capacity because of lane closure, or traffic congestion. To consider these time dependencies, DTA procedures are required.

The DTRAD DTA module represents the dynamic route choice behavior of drivers, using the specification of dynamic origin-destination matrices as flow input. Drivers choose their routes through the network based on the travel cost they experience (as determined by the simulation model). This allows traffic to be distributed over the network according to the time-dependent conditions. The modeling principles of D-TRAD include:

- It is assumed that drivers not only select the best route (i.e., lowest cost path) but some also select less attractive routes. The algorithm implemented by DTRAD archives several "efficient" routes for each O-D pair from which the drivers choose.
- The choice of one route out of a set of possible routes is an outcome of "discrete choice modeling." Given a set of routes and their generalized costs, the percentages of drivers that choose each route is computed. The most prevalent model for discrete choice modeling is the logit model. DTRAD uses a variant of Path-Size-Logit model (PSL). PSL overcomes the drawback of the traditional multinomial logit model by incorporating an additional deterministic path size correction term to address path overlapping in the random utility expression.
- DTRAD executes the TA algorithm on an abstract network representation called "the path network" which is built from the actual physical link-node analysis network. This execution continues until a stable situation is reached: the volumes and travel times on the edges of the path network do not change significantly from one iteration to the next. The criteria for this convergence are defined by the user.
- Travel "cost" plays a crucial role in route choice. In DTRAD, path cost is a linear summation of the generalized cost of each link that comprises the path. The generalized cost for a link, a, is expressed as

$$c_a = \alpha t_a + \beta l_a + \gamma s_a ,$$

where c_a is the generalized cost for link a, and α, β, and γ are cost coefficients for link travel time, distance, and supplemental cost, respectively. Distance and supplemental costs are defined as invariant properties of the network model, while travel time is a dynamic property dictated by prevailing traffic conditions. The DYNEV simulation model computes travel times on all edges in the network and DTRAD uses that information to constantly update the costs of paths. The route choice decision model in the next simulation iteration uses these updated values to adjust the route choice behavior. This way, traffic demands are dynamically re-assigned based on time dependent conditions. The interaction between the DTRAD traffic assignment and DYNEV II simulation models is depicted in Figure B-1. Each round of interaction is called a Traffic Assignment Session (TA session). A TA session is composed of multiple iterations, marked as loop B in the figure.

- The supplemental cost is based on the "survival distribution" (a variation of the exponential distribution). The Inverse Survival Function is a "cost" term in DTRAD to represent the potential risk of travel toward the plant:

  $s_a = -\beta \ln(p), 0 \le p \le 1; \beta > 0$

  $p = \frac{d_n}{d_0}$

  d_n = Distance of node, n, from the plant
  d_0=Distance from the plant where there is zero risk
  β = Scaling factor

The value of d_0 = 15 miles, the outer distance of the shadow region. Note that the supplemental cost, s_a, of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

Network Equilibrium

In 1952, John Wardrop wrote:

> *Under equilibrium conditions traffic arranges itself in congested networks in such a way that no individual trip-maker can reduce his path costs by switching routes.*

The above statement describes the "User Equilibrium" definition, also called the "Selfish Driver Equilibrium." It is a hypothesis that represents a [hopeful] condition that evolves over time as drivers search out alternative routes to identify those routes that minimize their respective "costs." It has been found that this "equilibrium" objective to minimize costs is largely realized by most drivers who routinely take the same trip over the same network at the same time (i.e., commuters). Effectively, such drivers "learn" which routes are best for them over time. Thus, the traffic environment "settles down" to a near-equilibrium state.

Clearly, since an emergency evacuation is a sudden, unique event, it does not constitute a long-term learning experience which can achieve an equilibrium state. Consequently, DTRAD was not designed as an equilibrium solution, but to represent drivers in a new and unfamiliar situation, who respond in a flexible manner to real-time information (either broadcast or observed) in such a way as to minimize their respective costs of travel.

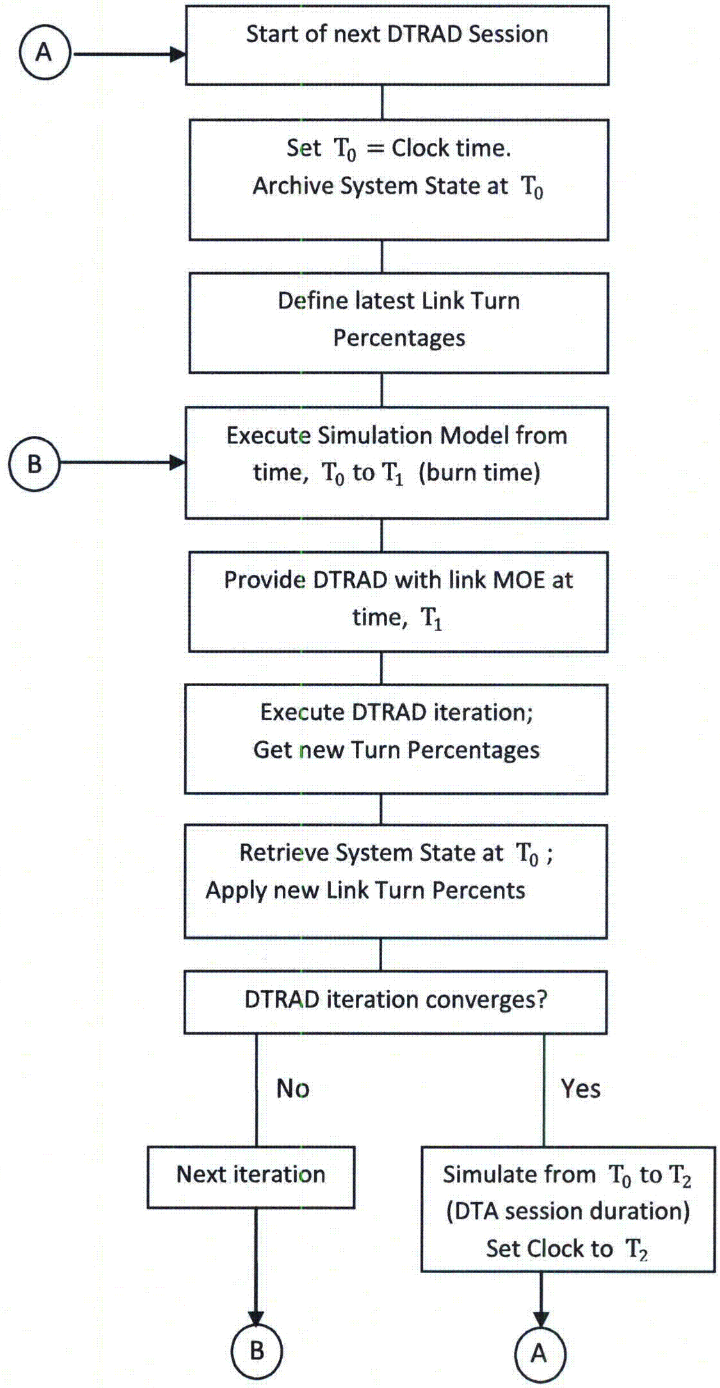


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

The DYNEV traffic simulation model is a *macroscopic* model that describes the operations of traffic flow in terms of aggregate variables: vehicles, flow rate, mean speed, volume, density, queue length, *on each link*, for each turn movement, during each Time Interval (simulation time step). The model generates trips from "sources" and from Entry Links and introduces them onto the analysis network at rates specified by the analyst based on the mobilization time distributions. The model simulates the movements of all vehicles on all network links over time until the network is empty. At intervals, the model outputs Measures of Effectiveness (MOE) such as those listed in Table C-1.

Model Features Include:

- Explicit consideration is taken of the variation in density over the time step; an iterative procedure is employed to calculate an average density over the simulation time step for the purpose of computing a mean speed for moving vehicles.
- Multiple turn movements can be serviced on one link; a separate algorithm is used to estimate the number of (fractional) lanes assigned to the vehicles performing each turn movement, based, in part, on the turn percents provided by the DTRAD model.
- At any point in time, traffic flow on a link is subdivided into two classifications: queued and moving vehicles. The number of vehicles in each classification is computed. Vehicle spillback, stratified by turn movement for each network link, is explicitly considered and quantified. The propagation of stopping waves from link to link is computed within each time step of the simulation. There is no "vertical stacking" of queues on a link.
- Any link can accommodate "source flow" from zones via side streets and parking facilities that are not explicitly represented. This flow represents the evacuating trips that are generated at the source.
- The relation between the number of vehicles occupying the link and its storage capacity is monitored every time step for every link and for every turn movement. If the available storage capacity on a link is exceeded by the demand for service, then the simulator applies a "metering" rate to the entering traffic from both the upstream feeders and source node to ensure that the available storage capacity is not exceeded.
- A "path network" that represents the specified traffic movements from each network link is constructed by the model; this path network is utilized by the DTRAD model.
- A two-way interface with DTRAD: (1) provides link travel times; (2) receives data that translates into link turn percentages.
- Provides MOE to animation software, EVAN
- Calculates ETE statistics

All traffic simulation models are data-intensive. Table C-2 outlines the necessary input data elements.

To provide an efficient framework for defining these specifications, the physical highway environment is represented as a network. The unidirectional links of the network represent roadway sections: rural, multi-lane, urban streets or freeways. The nodes of the network generally represent intersections or points along a section where a geometric property changes (e.g., a lane drop, change in grade or free flow speed).

Figure C-1 is an example of a small network representation. The freeway is defined by the sequence of links, (20,21), (21,22), and (22,23). Links (8001, 19) and (3, 8011) are Entry and Exit links, respectively. An arterial extends from node 3 to node 19 and is partially subsumed within a grid network. Note that links (21,22) and (17,19) are grade-separated.

Table C-1. Selected Measures of Effectiveness Output by DYNEV II

Measure	Units	Applies To
Vehicles Discharged	Vehicles	Link, Network, Exit Link
Speed	Miles/Hours (mph)	Link, Network
Density	Vehicles/Mile/Lane	Link
Level of Service	LOS	Link
Content	Vehicles	Network
Travel Time	Vehicle-hours	Network
Evacuated Vehicles	Vehicles	Network, Exit Link
Trip Travel Time	Vehicle-minutes/trip	Network
Capacity Utilization	Percent	Exit Link
Attraction	Percent of total evacuating vehicles	Exit Link
Max Queue	Vehicles	Node, Approach
Time of Max Queue	Hours:minutes	Node, Approach
Route Statistics	Length (mi); Mean Speed (mph); Travel Time (min)	Route
Mean Travel Time	Minutes	Evacuation Trips; Network

Table C-2. Input Requirements for the DYNEV II Model

HIGHWAY NETWORK

- Links defined by upstream and downstream node numbers
- Link lengths
- Number of lanes (up to 9) and channelization
- Turn bays (1 to 3 lanes)
- Destination (exit) nodes
- Network topology defined in terms of downstream nodes for each receiving link
- Node Coordinates (X,Y)
- Nuclear Power Plant Coordinates (X,Y)

GENERATED TRAFFIC VOLUMES

- On all entry links and source nodes (origins), by Time Period

TRAFFIC CONTROL SPECIFICATIONS

- Traffic signals: link-specific, turn movement specific
- Signal control treated as fixed time or actuated
- Location of traffic control points (these are represented as actuated signals)
- Stop and Yield signs
- Right-turn-on-red (RTOR)
- Route diversion specifications
- Turn restrictions
- Lane control (e.g., lane closure, movement-specific)

DRIVER'S AND OPERATIONAL CHARACTERISTICS

- Driver's (vehicle-specific) response mechanisms: free-flow speed, discharge headway
- Bus route designation.

DYNAMIC TRAFFIC ASSIGNMENT

- Candidate destination nodes for each origin (optional)
- Duration of DTA sessions
- Duration of simulation "burn time"
- Desired number of destination nodes per origin

INCIDENTS

- Identify and Schedule of closed lanes
- Identify and Schedule of closed links

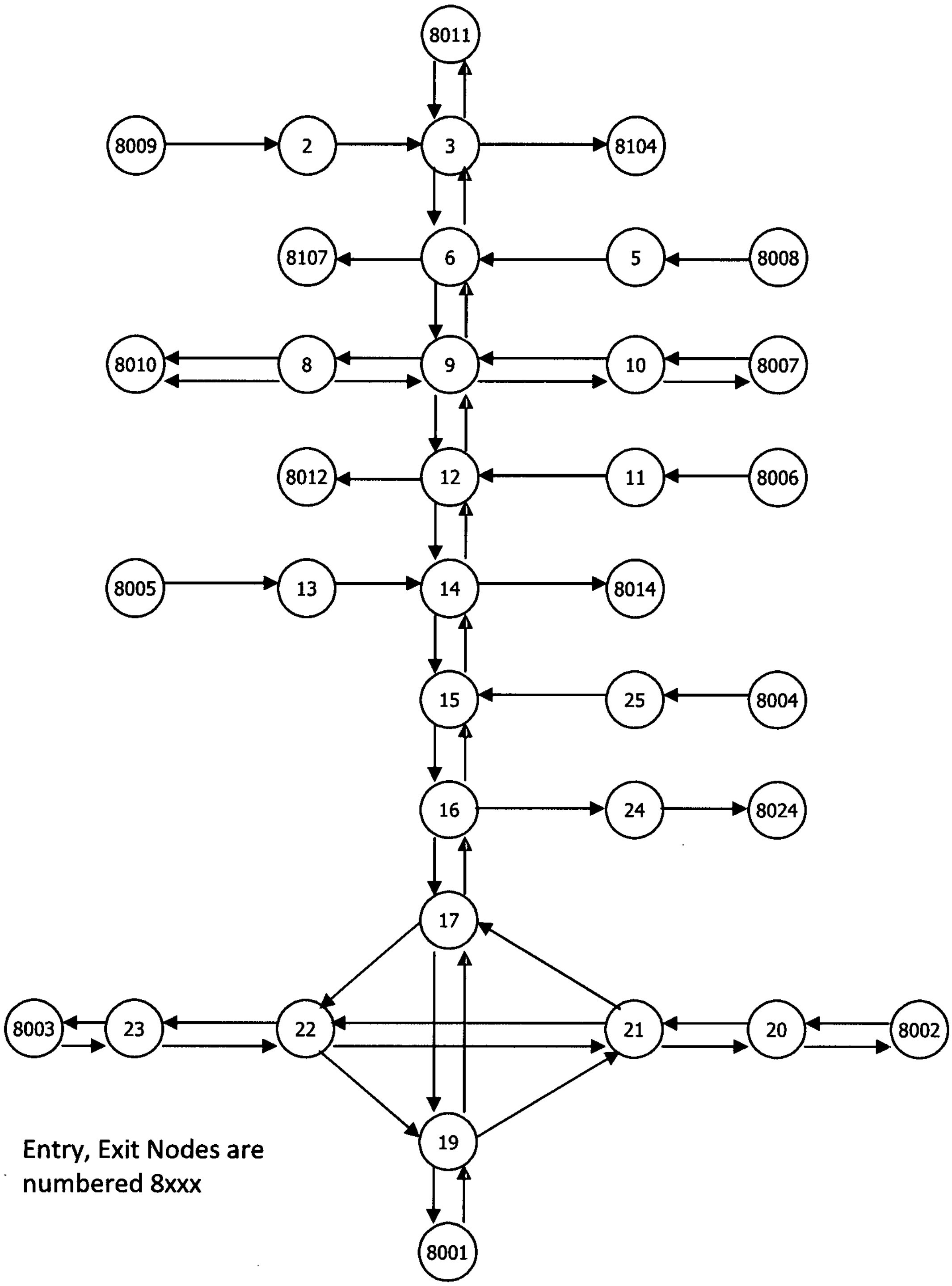


Figure C-1. Representative Analysis Network

C.1 Methodology

C.1.1 The Fundamental Diagram

It is necessary to define the fundamental diagram describing flow-density and speed-density relationships. Rather than "settling for" a triangular representation, a more realistic representation that includes a "capacity drop," (I-R)Q_{max}, at the critical density when flow conditions enter the forced flow regime, is developed and calibrated for each link. This representation, shown in Figure C-2, asserts a constant free speed up to a density, k_f, and then a linear reduction in speed in the range, $k_f \leq k \leq k_c = 45$ vpm, the density at capacity. In the flow-density plane, a quadratic relationship is prescribed in the range, $k_c < k \leq k_s = 95$ vpm which roughly represents the "stop-and-go" condition of severe congestion. The value of flow rate, Q_s, corresponding to k_s, is approximated at $0.7\,RQ_{max}$. A linear relationship between k_s and k_j completes the diagram shown in Figure C-2. Table C-3 is a glossary of terms.

The fundamental diagram is applied to moving traffic on every link. The specified calibration values for each link are: (1) Free speed, v_f ; (2) Capacity, Q_{max} ; (3) Critical density, $k_c = 45$ vpm ; (4) Capacity Drop Factor, R = 0.9 ; (5) Jam density, k_j . Then, $v_c = \frac{Q_{max}}{k_c}$, $k_f = k_c - \frac{(V_f - V_c)\,k_c^2}{Q_{max}}$. Setting $\bar{k} = k - k_c$, then $Q = RQ_{max} - \frac{RQ_{max}}{8333}\bar{k}^2$ for $0 \leq \bar{k} \leq \bar{k}_s = 50$. It can be shown that $Q = \left(0.98 - 0.0056\,\bar{k}\right) RQ_{max}$ for $\bar{k}_s \leq \bar{k} \leq \bar{k}_j$, where $\bar{k}_s = 50$ and $\bar{k}_j = 175$.

C.1.2 The Simulation Model

The simulation model solves a sequence of "unit problems." Each unit problem computes the movement of traffic on a link, for each specified turn movement, over a specified time interval (TI) which serves as the simulation time step for all links. Figure C-3 is a representation of the unit problem in the time-distance plane. Table C-3 is a glossary of terms that are referenced in the following description of the unit problem procedure.

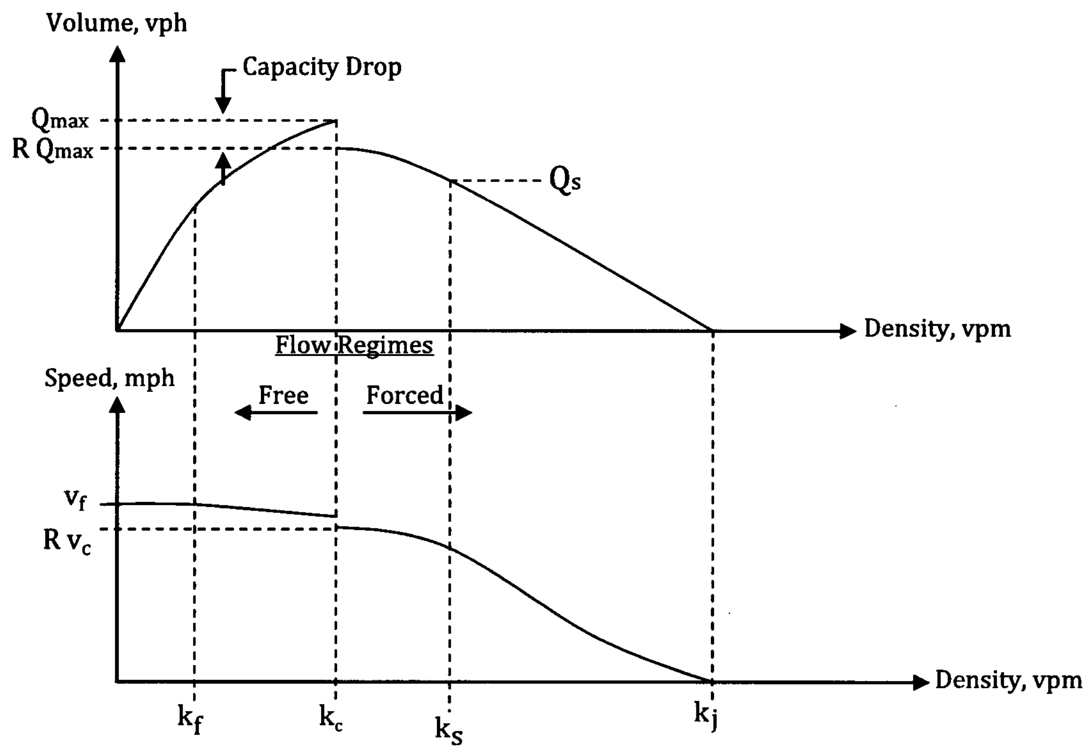


Figure C-2. Fundamental Diagrams

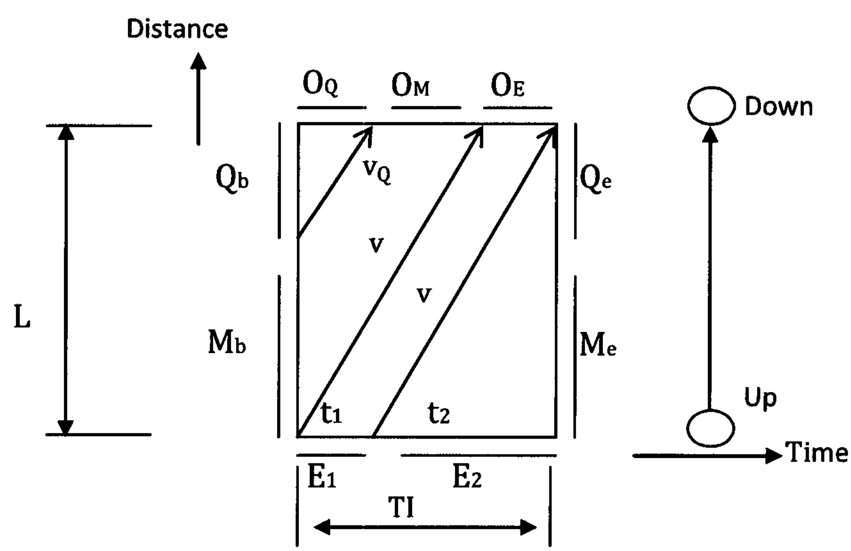


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

Table C-3. Glossary

Cap	The maximum number of vehicles, of a particular movement, that can discharge from a link within a time interval.
E	The number of vehicles, of a particular movement, that enter the link over the time interval. The portion, E_{TI}, can reach the stop-bar within the TI.
G/C	The green time: cycle time ratio that services the vehicles of a particular turn movement on a link.
h	The mean queue discharge headway, seconds.
k	Density in vehicles per lane per mile.
$\bar{k}$	The average density of <u>moving</u> vehicles of a particular movement over a TI, on a link.
L	The length of the link in feet.
L_b , L_e	The queue length in feet of a particular movement, at the [beginning, end] of a time interval.
LN	The number of lanes, expressed as a floating point number, allocated to service a particular movement on a link.
L_v	The mean effective length of a queued vehicle including the vehicle spacing, feet.
M	Metering factor (Multiplier): 1.
M_b , M_e	The number of moving vehicles on the link, of a particular movement, that are moving at the [beginning, end] of the time interval. These vehicles are assumed to be of equal spacing, over the length of link upstream of the queue.
O	The total number of vehicles of a particular movement that are discharged from a link over a time interval.
O_Q , O_M , O_E	The components of the vehicles of a particular movement that are discharged from a link within a time interval: vehicles that were Queued at the beginning of the TI; vehicles that were Moving within the link at the beginning of the TI; vehicles that Entered the link during the TI.
P_x	The percentage, expressed as a fraction, of the total flow on the link that executes a particular turn movement, x.

Q_b , Q_e	The number of queued vehicles on the link, of a particular turn movement, at the [beginning, end] of the time interval.
Q_{max}	The maximum flow rate that can be serviced by a link for a particular movement in the absence of a control device. It is specified by the analyst as an estimate of link capacity, based upon a field survey, with reference to the HCM (10).
R	The factor that is applied to the capacity of a link to represent the "capacity drop" when the flow condition moves into the forced flow regime. The lower capacity at that point is equal to RQ_{max} .
RCap	The remaining capacity available to service vehicles of a particular movement after that queue has been completely serviced, within a time interval, expressed as vehicles.
S_x	Service rate for movement x, vehicles per hour (vph).
t_1	Vehicles of a particular turn movement that enter a link over the first t_1 seconds of a time interval, can reach the stop-bar (in the absence of a queue down-stream) within the same time interval.
TI	The time interval, in seconds, which is used as the simulation time step.
v	The mean speed of travel, in feet per second (fps) or miles per hour (mph), of moving vehicles on the link.
v_Q	The mean speed of the last vehicle in a queue that discharges from the link within the TI. This speed differs from the mean speed of moving vehicles, v.
W	The width of the intersection in feet. This is the difference between the link length which extends from stop-bar to stop-bar and the block length.

The formulation and the associated logic presented below are designed to solve the unit problem for each sweep over the network (discussed below), for each turn movement serviced on each link that comprises the evacuation network, and for each TI over the duration of the evacuation.

Given $= Q_b, M_b, L, TI, E_0, LN, {}^G/_C, h, L_v, R_0, L_c, E, M$
Compute $= O, Q_e, M_e$
Define $O = O_Q + O_M + O_E \; ; \; E = E_1 + E_2$

1. For the first sweep, s = 1, of this TI, get initial estimates of mean density, k_0, the $R -$ factor, R_0 and entering traffic, E_0, using the values computed for the final sweep of the prior TI. For each subsequent sweep, $s > 1$, calculate $E = \sum_i P_i \; O_i + S$ where P_i, O_i are the relevant turn percentages from feeder link, i, and its total outflow (possibly metered) over this TI; S is the total source flow (possibly metered) during the current TI.
   Set iteration counter, n = 0, $k = k_0$, and $E = E_0$.

2. Calculate $v(k)$ such that $k \leq 130$ using the analytical representations of the fundamental diagram.
   Calculate $\text{Cap} = \frac{Q_{max}(TI)}{3600} \left({}^G/_C\right) LN$, in vehicles, this value may be reduced due to metering
   Set $R = 1.0$ if ${}^G/_C < 1$ or if $k \leq k_c$; Set $R = 0.9$ only if ${}^G/_C = 1$ and $k > k_c$
   Calculate queue length, $L_b = Q_b \frac{L_v}{LN}$

3. Calculate $t_1 = TI - \frac{L}{v}$. If $t_1 < 0$, set $t_1 = E_1 = O_E = 0$; Else, $E_1 = E \frac{t_1}{TI}$.

4. Then $E_2 = E - E_1 \; ; \; t_2 = TI - t_1$

5. If $Q_b \geq \text{Cap}$, then
   $O_Q = \text{Cap}, O_M = O_E = 0$
   If $t_1 > 0$, then
   $Q'_e = Q_b + M_b + E_1 - \text{Cap}$
   Else
   $Q'_e = Q_b - \text{Cap}$
   End if
   Calculate Q_e and M_e using Algorithm A (below)

6. Else $(Q_b < \text{Cap})$
   $O_Q = Q_b$, $\text{RCap} = \text{Cap} - O_Q$

7. If $M_b \leq \text{RCap}$, then

8. If $t_1 > 0$, $O_M = M_b, O_E = \min\left(RCap - M_b, \frac{t_1\ Cap}{TI}\right) \geq 0$

$Q'_e = E_1 - O_E$

If $Q'_e > 0$, then

Calculate Q_e, M_e with Algorithm A

Else

$Q_e = 0,\ M_e = E_2$

End if

Else $(t_1 = 0)$

$O_M = \left(\frac{v(TI) - L_b}{L - L_b}\right) M_b$ and $O_E = 0$

$M_e = M_b - O_M + E;\ Q_e = 0$

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$, then

$O_M = RCap,\ Q'_e = M_b - O_M + E_1$

Calculate Q_e and M_e using Algorithm A

10. Else $(t_1 = 0)$

$M_d = \left[\left(\frac{v(TI) - L_b}{L - L_b}\right) M_b\right]$

If $M_d > RCap$, *then*

$O_M = RCap$

$Q'_e = M_d - O_M$

Apply Algorithm A to calculate Q_e and M_e

Else

$O_M = M_d$

$M_e = M_b - O_M + E$ and $Q_e = 0$

End if

End if

End if

End if

11. Calculate a new estimate of average density, $\bar{k}_n = \frac{1}{4}[k_b + 2\,k_m + k_e]$,

where k_b = density at the beginning of the TI

k_e = density at the end of the TI

k_m = density at the mid-point of the TI

All values of density apply only to the <u>moving</u> vehicles.

If $|\bar{k}_n - \bar{k}_{n-1}| > \epsilon$ and $n < N$

where $N =$ max number of iterations, and ϵ is a convergence criterion, then

12. set $n = n + 1$, and return to step 2 to perform iteration, n, using $k = \bar{k}_n$.
End if

Computation of unit problem is now complete. Check for excessive inflow causing spillback.

13. If $Q_e + M_e > \frac{(L-W)\,LN}{L_v}$, then

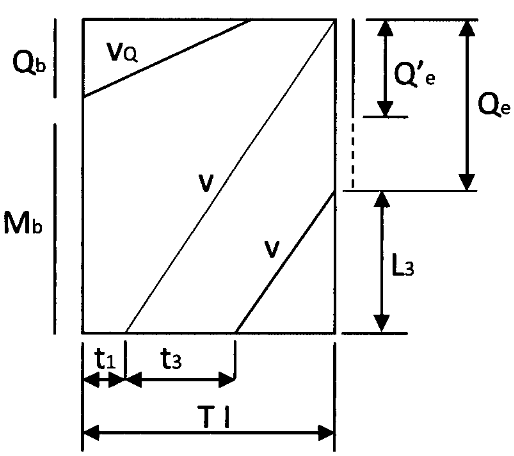
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W)\cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

$$M = 1 - \frac{SB}{(E+S)} \geq 0 \text{, where M is the metering factor (over all movements).}$$

This metering factor is assigned appropriately to all feeder links and to the source flow, to be applied during the next network sweep, discussed later.

Algorithm A

This analysis addresses the flow environment over a TI during which moving vehicles can join a standing or discharging queue. For the case shown, $Q_b \leq Cap$, with $t_1 > 0$ and a queue of length, Q'_e, formed by that portion of M_b and E that reaches the stop-bar within the TI, but could not discharge due to inadequate capacity. That is, $Q_b + M_b + E_1 > Cap$. This queue length, $Q'_e = Q_b + M_b + E_1 - Cap$ can be extended to Q_e by traffic entering the approach during the current TI, traveling at speed, v, and reaching the rear of the queue within the TI. A portion of the entering vehicles, $E_3 = E\,\frac{t_3}{TI}$, will likely join the queue. This analysis calculates t_3, Q_e and M_e for the input values of L, TI, v, E, t, L_v, LN, Q'_e .



When $t_1 > 0$ and $Q_b \leq Cap$:

Define: $L'_e = Q'_e\,\frac{L_v}{LN}$. From the sketch, $L_3 = v(TI - t_1 - t_3) = L - (Q'_e + E_3)\frac{L_v}{LN}$.

Substituting $E_3 = \frac{t_3}{TI}\,E$ yields: $-vt_3 + \frac{t_3}{TI}\,E\,\frac{L_v}{LN} = L - v(TI - t_1) - L'_e$. Recognizing that the first two terms on the right hand side cancel, solve for t_3 to obtain:

$$t_3 = \frac{L'_e}{\left[v - \frac{E}{TI}\frac{L_v}{LN}\right]} \qquad \text{such that} \quad 0 \le t_3 \le TI - t_1$$

If the denominator, $\left[v - \frac{E}{TI}\frac{L_v}{LN}\right] \le 0$, set $t_3 = TI - t_1$.

$$\text{Then, } Q_e = Q'_e + E\,\frac{t_3}{TI} \quad , \qquad M_e = E\left(1 - \frac{t_1 + t_3}{TI}\right)$$

The complete Algorithm A considers all flow scenarios; space limitation precludes its inclusion, here.

C.1.3 Lane Assignment

The "unit problem" is solved for each turn movement on each link. Therefore it is necessary to calculate a value, LN_x , of allocated lanes for each movement, x. If in fact all lanes are specified by, say, arrows painted on the pavement, either as full lanes or as lanes within a turn bay, then the problem is fully defined. If however there remain unchannelized lanes on a link, then an analysis is undertaken to subdivide the number of these physical lanes into turn movement specific virtual lanes, LN_x.

C.2 Implementation

C.2.1 Computational Procedure

The computational procedure for this model is shown in the form of a flow diagram as Figure C-4. As discussed earlier, the simulation model processes traffic flow for each link independently over TI that the analyst specifies; it is usually 60 seconds or longer. The first step is to execute an algorithm to define the sequence in which the network links are processed so that as many links as possible are processed after their feeder links are processed, within the same network sweep. Since a general network will have many closed loops, it is not possible to guarantee that every link processed will have all of its feeder links processed earlier.

The processing then continues as a succession of time steps of duration, TI, until the simulation is completed. Within each time step, the processing performs a series of "sweeps" over all network links; this is necessary to ensure that the traffic flow is synchronous over the entire network. Specifically, the sweep ensures continuity of flow among all the network links; in the context of this model, this means that the values of E, M, and S are all defined for each link such that they represent the synchronous movement of traffic from each link to all of its outbound links. These sweeps also serve to compute the metering rates that control spillback.

Within each sweep, processing solves the "unit problem" for each turn movement on each link. With the turn movement percentages for each link provided by the DTRAD model, an algorithm allocates the number of lanes to each movement serviced on each link. The timing at a signal, if any, applied at the downstream end of the link, is expressed as a G/C ratio, the signal timing needed to define this ratio is an input requirement for the model. The model also has the capability of representing, with macroscopic fidelity, the actions of actuated signals responding to the time-varying competing demands on the approaches to the intersection.

The solution of the unit problem yields the values of the number of vehicles, O, that discharge from the link over the time interval and the number of vehicles that remain on the link at the end of the time interval as stratified by queued and moving vehicles: Q_e and M_e. The procedure considers each movement separately (multi-piping). After all network links are processed for a given network sweep, the updated consistent values of entering flows, E; metering rates, M; and source flows, S are defined so as to satisfy the "no spillback" condition. The procedure then performs the unit problem solutions for all network links during the following sweep.

Experience has shown that the system converges (i.e., the values of E, M and S "settle down" for all network links) in just two sweeps if the network is entirely undersaturated or in four sweeps in the presence of extensive congestion with link spillback. (The initial sweep over each link uses the final values of E and M, of the prior TI). At the completion of the final sweep for a TI, the procedure computes and stores all measures of effectiveness for each link and turn movement for output purposes. It then prepares for the following time interval by defining the values of Q_b and M_b for the start of the next TI as being those values of Q_e and M_e at the end of the prior TI. In this manner, the simulation model processes the traffic flow over time until the end of the run. Note that there is no space-discretization other than the specification of network links.

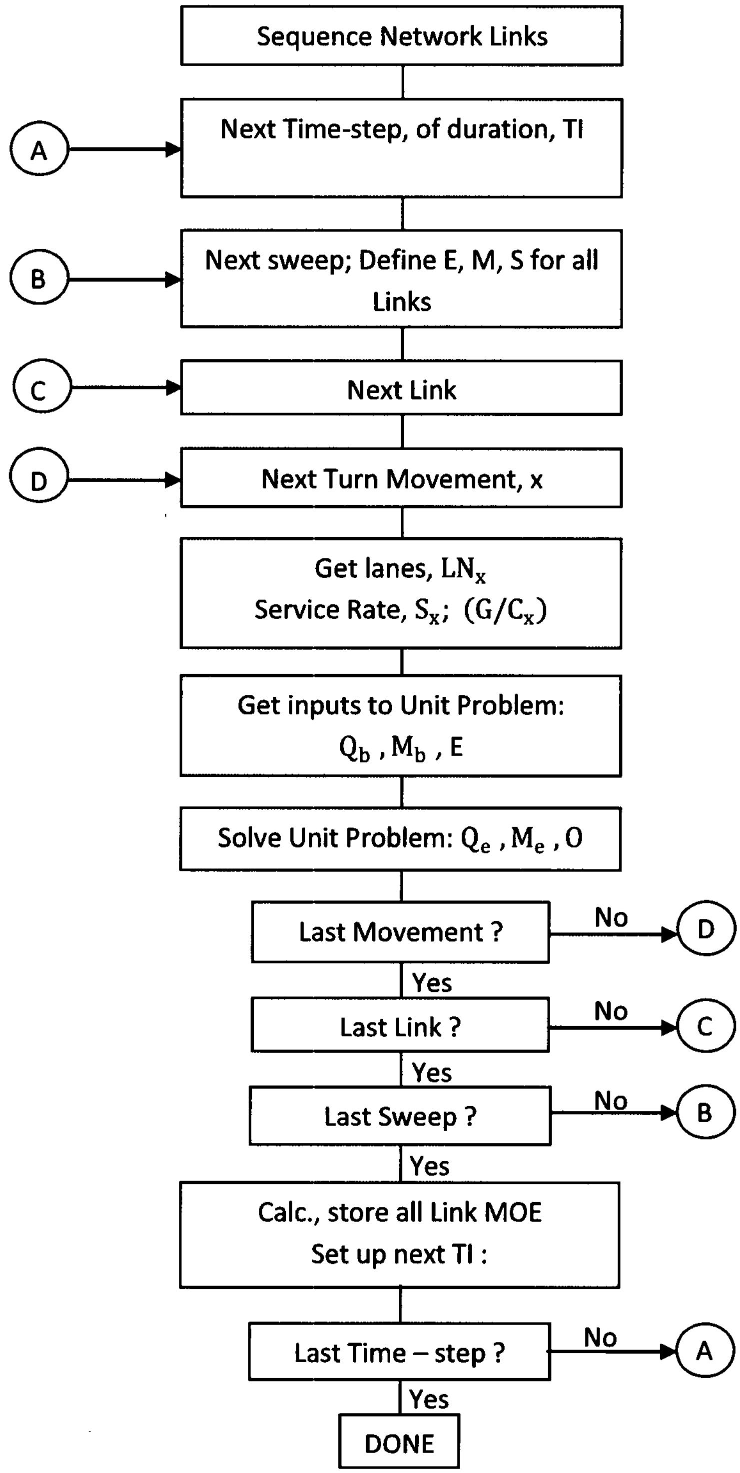


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

C.2.2 Interfacing with Dynamic Traffic Assignment (DTRAD)

The DYNEV II system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. Thus, an algorithm was developed to identify an appropriate set of destination nodes for each origin based on its location and on the expected direction of travel. This algorithm also supports the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next.

Figure B-1 depicts the interaction of the simulation model with the DTRAD model in the DYNEV II system. As indicated, DYNEV II performs a succession of DTRAD "sessions;" each such session computes the turn link percentages for each link, that remain constant for the session duration, $[T_0, T_2]$, specified by the analyst. The end product is the assignment of traffic volumes from each origin to paths connecting it with its destinations in such a way as to minimize the network-wide cost function. The output of the DTRAD model is a set of updated link turn percentages which represent this assignment of traffic.

As indicated in Figure B-1, the simulation model supports the DTRAD session by providing it with operational link MOE that are needed by the path choice model and included in the DTRAD cost function. These MOE represent the operational state of the network at a time, $T_1 \leq T_2$, which lies within the session duration, $[T_0, T_2]$. This "burn time," $T_1 - T_0$, is selected by the analyst. For each DTRAD iteration, the simulation model computes the change in network operations over this burn time using the latest set of link turn percentages computed by the DTRAD model. Upon convergence of the DTRAD iterative procedure, the simulation model accepts the latest turn percentages provided by the DTA model, returns to the origin time, T_0, and executes until it arrives at the end of the DTRAD session duration at time, T_2. At this time the next DTA session is launched and the whole process repeats until the end of the DYNEV II run.

Additional details are presented in Appendix B.

APPENDIX D

Detailed Description of Study Procedure

D. DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute ETE. The individual steps of this effort are represented as a flow diagram in Figure D-1. Each numbered step in the description that follows corresponds to the numbered element in the flow diagram.

Step 1

The first activity was to obtain EPZ boundary information and create a GIS base map. The base map extends beyond the Shadow Region which extends approximately 15 miles (radially) from the power plant location. The base map incorporates the local roadway topology, a suitable topographic background and the EPZ and sub-area boundaries.

Step 2

2010 U.S. Census block information was obtained in GIS format. This information was used to estimate the resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. Employee data were estimated using the U.S. Census Bureau's Longitudinal Employer-Household Dynamics interactive website[1], and from phone calls to major employers.. Transient data were obtained from local/state emergency management agencies and from phone calls to transient attractions. Information concerning schools, medical and other types of special facilities within the EPZ was obtained from county and municipal sources, augmented by telephone contacts with the identified facilities.

Step 3

A kickoff meeting was conducted with major stakeholders (state and local emergency managers, on-site and off-site utility emergency managers, local and state law enforcement agencies). The purpose of the kickoff meeting was to present an overview of the work effort, identify key agency personnel, and indicate the data requirements for the study. Specific requests for information were presented to local emergency managers. Unique features of the study area were discussed to identify the local concerns that should be addressed by the ETE study.

Step 4

Next, a physical survey of the roadway system in the study area was conducted to determine the geometric properties of the highway sections, the channelization of lanes on each section of roadway, whether there are any turn restrictions or special treatment of traffic at intersections, the type and functioning of traffic control devices, gathering signal timings for pre-timed traffic signals, and to make the necessary observations needed to estimate realistic values of roadway capacity.

[1] http://lehdmap.did.census.gov/

Step 5

A telephone survey of households within the EPZ was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the EPZ population. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the UNITES software developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4). Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. 2010 U.S. Census data were overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 7

The EPZ is subdivided into 19 sub-areas. Based on wind direction and speed, regions (groupings of sub-areas) that may be advised to evacuate, were developed.

The need for evacuation can occur over a range of time-of-day, day-of-week, seasonal and weather-related conditions. Scenarios were developed to capture the variation in evacuation demand, highway capacity and mobilization time, for different time of day, day of the week, time of year, and weather conditions.

Step 8

The input stream for the DYNEV II model, which integrates the dynamic traffic assignment and distribution model, DTRAD, with the evacuation simulation model, was created for a prototype evacuation case – the evacuation of the entire EPZ for a representative scenario.

Step 9

After creating this input stream, the DYNEV II System was executed on the prototype evacuation case to compute evacuating traffic routing patterns consistent with the appropriate NRC guidelines. DYNEV II contains an extensive suite of data diagnostics which check the completeness and consistency of the input data specified. The analyst reviews all warning and error messages produced by the model and then corrects the database to create an input stream that properly executes to completion.

The model assigns destinations to all origin centroids consistent with a (general) radial evacuation of the EPZ and Shadow Region. The analyst may optionally supplement and/or replace these model-assigned destinations, based on professional judgment, after studying the topology of the analysis highway network. The model produces link and network-wide measures of effectiveness as well as estimates of evacuation time.

Step 10

The results generated by the prototype evacuation case are critically examined. The examination includes observing the animated graphics (using the EVAN software which operates on data produced by DYNEV II) and reviewing the statistics output by the model. This is a labor-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the results.

Essentially, the approach is to identify those bottlenecks in the network that represent locations where congested conditions are pronounced and to identify the cause of this congestion. This cause can take many forms, either as excess demand due to high rates of trip generation, improper routing, a shortfall of capacity, or as a quantitative flaw in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are satisfactory; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment and experience based upon the results obtained in previous applications of the model and a comparison of the results of the latest prototype evacuation case iteration with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 13. Otherwise, proceed to Step 11.

Step 11

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 12

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 11. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 13

Evacuation of transit-dependent evacuees and special facilities are included in the evacuation analysis. Fixed routing for transit buses and for school buses, ambulances, and other transit vehicles are introduced into the final prototype evacuation case data set. DYNEV II generates route-specific speeds over time for use in the estimation of evacuation times for the transit dependent and special facility population groups.

Step 14

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the highway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 15

All evacuation cases are executed using the DYNEV II System to compute ETE. Once results were available, quality control procedures were used to assure the results were consistent, dynamic routing was reasonable, and traffic congestion/bottlenecks were addressed properly.

Step 16

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes were used to compute evacuation time estimates for transit-dependent permanent residents, schools, hospitals, and other special facilities.

Step 17

The simulation results are analyzed, tabulated and graphed. The results were then documented, as required by NUREG/CR-7002.

Step 18

Following the completion of documentation activities, the ETE criteria checklist was completed. An appropriate report reference is provided for each criterion provided in the checklist.

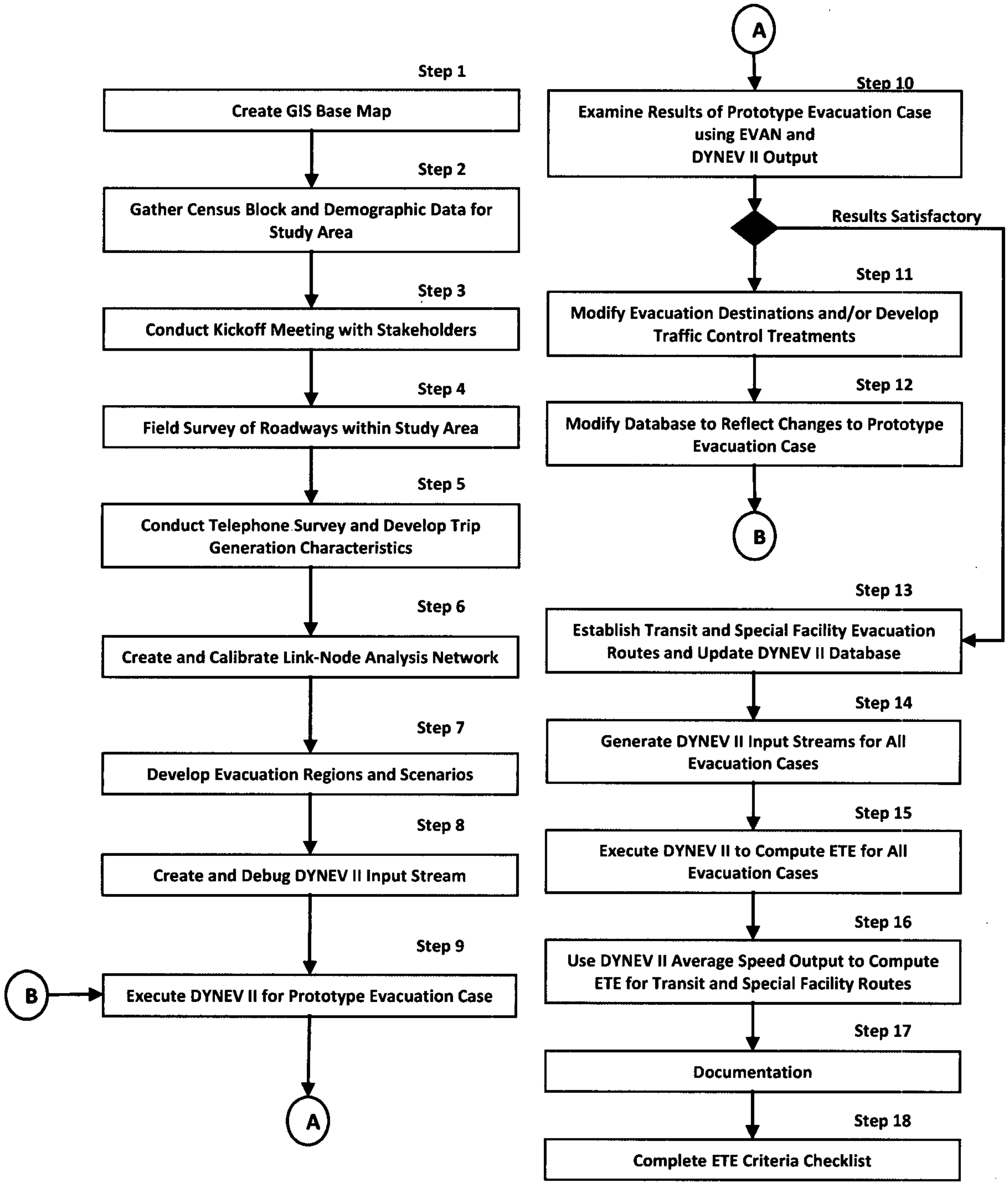


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

E. SPECIAL FACILITY DATA

The following tables list population information, as of April 2012, for special facilities that are located within the Beaver Valley Power Station EPZ. Special facilities are defined as schools, day care centers, hospitals and other medical care facilities, and a correctional facility. Transient population data is included in the tables for recreational areas, golf course and lodging facilities. Employment data is included in the table for major employers. Each table is grouped by county. The location of each facility is defined by its straight-line distance (miles) and direction (magnetic bearing) from the center point of the plant. Maps of each special facility, recreational area, golf course, lodging facility, and major employer are also provided.

Table E-1. Schools within the EPZ

Sub-Area	Distance (miles)	Direc-tion	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
BEAVER COUNTY, PA								
P-1	1.6	NW	Midland Neel Elementary/Middle School	173 7th St	Midland	724-643-8650	375	23
P-1	1.3	NW	Lincoln Park Performing Arts Charter School	1 Lincoln Park	Midland	724-764-7200	600	32
P-1	0.9	NW	Prima Learning Center	One 13th Street	Midland	724-643-8184	120	22
P-3	3.2	NNE	Western Beaver Junior-Senior High School	216 Engle Rd	Industry	724-643-8500	385	37
P-4	4.5	SSE	Bethel Christian School	4549 Pennsylvania 151	West Aliquippa	724-375-5800	50	9
P-5	3.7	S	South Side Elementary School	4949 Pennsylvania 151	Hookstown	724-573-9581	604	44
P-5	3.7	S	South Side High School	4949 Pennsylvania 151	Hookstown	724-573-9581	463	36
P-5	3.7	S	South Side Middle School	4949 Pennsylvania 151	Hookstown	724-573-9581	333	25
P-7	10.6	NNE	Blackhawk Intermediate School	635 Shenango Rd	Beaver Falls	724-843-5050	625	39
P-7	5.3	NNW	Fairview Elementary School	343 Ridgemont Drive	Midland	724-643-9680	365	32
P-7	10.0	NNE	Highland Middle School	402 Shenango Rd	Beaver Falls	724-843-1700	483	36
P-8	7.9	NE	Beaver Area Academic Charter School	Gypsy Glen Rd	Beaver	724-774-0250	79	3
P-8	8.0	NE	Beaver Area High School	1 Gypsy Glen Rd	Beaver	724-774-0250	735	32
P-8	7.5	NE	Beaver Area Middle School	Gypsy Glen Rd	Beaver	724-774-4010	336	29
P-8	8.4	NE	College Square Elementary School	375 College Ave	Beaver	724-774-9126	442	24
P-8	8.0	NE	Dutch Ridge Elementary	2220 Dutch Ridge Rd	Beaver	724-774-1017	610	39
P-8	10.1	NNE	Patterson Primary School	701 Darlington Rd	Beaver Falls	724-843-1268	221	16
P-8	8.9	NE	Sts. Peter and Paul School	546 Melrose Ave	Ambridge	724-266-5059	195	11
P-9	6.9	ENE	Beaver County Career & Technology Center	145 Poplar Ave	Monaca	724-728-5800	317	22
P-9	7.2	ENE	Center Grange Primary School	225 Center Grange Rd	West Aliquippa	724-775-8201	615	33
P-9	7.3	ENE	Central Valley High School	160 Baker Rd Ext	Monaca	724-775-4300	853	57
P-9	7.3	ENE	Central Valley Middle School	160 Baker Rd Ext	Monaca	724-775-8200	630	42
P-9	7.1	ENE	Community College of Beaver County	Commuter colleges have same travel patterns as transients. See Table E-4.				

Sub-Area	Distance (miles)	Direc-tion	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
P-9	8.1	ENE	Penn State - Beaver Campus	Commuter colleges have same travel patterns as transients. See Table E-4.				
P-9	9.6	ENE	St. John the Baptist School	1501 Virginia Ave	Monaca	724-775-5774	233	11
P-9	7.6	ENE	Todd Lane Elementary School	113 Todd Lane	Monaca	724-775-1050	541	32
P-10	8.2	E	Aliquippa Elementary School	840 21st St	West Aliquippa	724- 857-7550	472	44
P-10	9.2	E	Aliquippa Jr./Sr. High School	100 Harding Ave	West Aliquippa	724-857-7515	728	39
P-10	9.8	E	Hope Christian Academy	434 Franklin Ave	West Aliquippa	724-375-1016	22	9
P-10	8.7	ESE	Hopewell Elementary School	3000 Kane Rd	West Aliquippa	724-375-1111	345	21
P-10	9.3	ESE	Hopewell Junior High School	2354 Brodhead Rd	West Aliquippa	724-375-7765	740	51
P-10	9.8	ESE	Hopewell Senior High School	1215 Longvue Ave	West Aliquippa	724-378-8565	880	57
P-10	9.3	ESE	Margaret Ross Elementary School	1955 Maratta Rd	West Aliquippa	724-375-2956	200	14
P-10	9.5	ESE	Our Lady of Fatima School	3005 Fatima Dr	West Aliquippa	724-375-7565	202	11
P-11	7.7	SE	Independence Elementary School	103 School Rd	West Aliquippa	724-375-3201	310	17
P-12	5.1	S	Pleasant Hills Wesleyan Academy	466 Pleasant Hill Rd	Hookstown	724-573-9182	12	2
						Beaver County Subtotals:	*14,121*	*1,374*
COLUMBIANA COUNTY, OH								
O-2	7.8	W	American Spirit Academy	46682 Florence St	East Liverpool	330-385-5588	151	22
O-2	7.1	W	East Liverpool High School	100 Maine Blvd	East Liverpool	330-386-8777	975	81
O-2	7.1	W	East Liverpool Jr. High School	100 Maine Blvd	East Liverpool	330-386-8750	742	62
O-2	7.6	W	Kent State University	Commuter colleges have same travel patterns as transients. See Table E-4.				
O-2	8.7	WNW	LaCroft Elementary School	2460 Boring Lane	East Liverpool	330-386-8774	504	50
O-2	7.1	W	North Elementary School	90 Maine Blvd	East Liverpool	330-386-8772	439	40
O-2	7.8	W	Westgate Middle School	810 West 8th St	East Liverpool	330-386-8765	327	60
O-3	8.3	WNW	Calcutta Elementary School	15482 State Route170	Calcutta	330-386-8709	390	30
O-3	8.4	WNW	Employment Development Center	15529 Sprucevale Rd	East Liverpool	330-385-2970	80	20
						Columbiana County Subtotals:	*3,608*	*365*
HANCOCK COUNTY, WV								
W-1	6.8	W	Allison Elementary School	600 Railroad Street	Chester	304-387-1915	439	26
W-2	8.7	SW	Oak Glen High School	195 Golden Bear Dr	New Cumberland	304-564-3500	600	39

Sub-Area	Distance (miles)	Direc-tion	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
W-2	8.6	SW	Oak Glen Middle School	600 Indiana Ave	Chester	304-387-2363	627	41
W-3	9.9	SW	New Manchester Elementary School	128 High St	New Cumberland	304-564-3242	391	24
						Hancock County Subtotals:	*2,057*	*152*
						TOTAL:	**19,786**	**1,891**
SHADOW REGION								
S.R.	11.1	ESE	Ambridge Sr. High School	909 Duss Ave	Ambridge	724-266-2833	762	51
S.R.	12.0	ENE	Ambridge Jr. High School	401 First Street	Freedom	724-266-2833	411	28
S.R.	10.0	N	Blackhawk High School	500 Blackhawk Rd	Beaver Falls	724-846-9600	1,073	81
S.R.	11.9	ENE	Economy Elementary School	1000 1st Street	Freedom	724-266-2833	636	43
S.R.	11.7	ESE	Highland Elementary School	1101 Highland Avenue	Ambridge	724-266-2833	606	41
S.R.	10.4	NE	New Brighton Area Elementary School	3200 43rd St	New Brighton	724-843-1194	729	49
S.R.	10.3	NE	New Brighton Area Middle School	901 Penn Ave	New Brighton	724-846-8100	408	28
S.R.	10.5	NE	New Brighton Area High School	3200 43rd St # 2	New Brighton	724-846-1050	553	37
S.R.	14.0	E	North Hills Christian School	3151 Conway Wall Rose Rd	Baden	724-266-1922	81	6
S.R.	13.1	N	Northwestern Primary School	256 Elmwood Blvd	Darlington	724-827-2116	331	23
S.R.	11.1	E	Quigley Catholic High School	200 Quigley Dr	Baden	724-869-2188	220	15
S.R.	11.0	E	State Street Elementary School	600 Harmony Rd	Baden	724-266-2833	308	21
S.R.	11.6	WSW	John D. Rockefeller Career Center	95 Rockyside Rd	New Cumberland	304-564-4058	460	22
						Shadow Region Totals:	*6,578*	*445*

Table E-2. Medical Facilities within the EPZ

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Cap-acity	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
BEAVER COUNTY, PA											
P-7	5.9	NNE	Beaver Meadows	5130 Tuscarawas Rd	Beaver	724-495-1600	83	70	46	24	0
P-7	5.9	NNE	Beaver Valley Nursing & Rehabilitation	5130 Tuscarawas Rd	Beaver	724-495-1600	83	69	60	9	0
P-7	8.0	NNW	Lakeview Personal Care	498 Lisbon Rd	Darlington	724-495-6139	70	69	66	3	0
P-8	10.6	NNE	Cambridge Village	1600 Darlington Rd	Beaver Falls	724-846-1400	100	78	58	20	0
P-8	8.0	NE	Friendship Ridge	246 Friendship Circle	Beaver	724-775-7100	589	548	352	163	33
P-8	8.5	NE	Heritage Valley - Beaver	1000 Dutch Ridge Road	Beaver	724-728-7000	250	220	140	66	14
P-8	7.1	NNE	Trinity Oaks Care Center	160 Chapel Rd	Beaver	724-728-6257	24	18	13	5	0
P-9	5.8	E	Gateway Rehabilitation Center	100 Moffett Run Rd	Aliquippa	724-378-4461	148	132	132	0	0
P-9	5.8	E	Gateway Rehabilitation Center - Moffett House	1215 7th Ave	Beaver Falls	724-846-6145	25	24	24	0	0
P-10	7.4	E	Beaver Elder Care & Rehabilitation Center	616 Golf Course Rd	West Aliquippa	724-375-0345	67	53	35	16	2
P-10	8.4	E	Hunter's Personal Care	1916 Main St	West Aliquippa	724-378-1205	21	15	12	1	2
S.R.	11.0	NNE	Elmcroft of Chippewa	104 Pappan Business Dr	Beaver Falls	724-891-3333	85	70	53	17	0
						Beaver County Subtotals:	*1,545*	*1,366*	*991*	*324*	*51*
COLUMBIANA COUNTY, OH											
O-2	8.1	W	East Liverpool City Hospital	425 West 5th St	East Liverpool	330-385-7200	154	67	42	15	10
O-2	7.4	WNW	East Liverpool Convalescent Center #1	709 Armstrong La	East Liverpool	330-385-3600	50	37	15	19	3

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Cap-acity	Current Census	Ambul-atory Patients	Wheel-chair Patients	Bed-ridden Patients
O-2	6.9	W	Nentwick Nursing Home	500 Selfridge St	East Liverpool	330-385-5001	100	71	45	22	4
O-3	8.8	WNW	Calcutta Health Care	48444 Bell School Rd	East Liverpool	330-385-7100	121	99	63	30	6
						Columbiana County Subtotals:	*425*	*274*	*165*	*86*	*23*
HANCOCK COUNTY, WV											
W-1	6.2	W	The Orchard at Fox Crest	125 Fox Ln	Chester	304-387-0101	137	84	24	55	5
						Hancock County Subtotals:	*137*	*84*	*24*	*55*	*5*
						TOTAL:	**2,107**	**1,724**	**1,180**	**465**	**79**

Table E-3. Major Employers within the EPZ

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Employees (max shift)	% Non-EPZ	Employees (Non EPZ)
BEAVER COUNTY, PA									
P-1	1.2	NW	Alleghany Ludlum, Jewel Acquisition, LLC	950 10th St	Midland	724-773-2700	293	41.3%	121
P-1	0.0	-	Beaver Valley Power Station	Shippingport Rd	Shippingport	412-393-5424	556	60.0%	334
P-1	1.2	NE	Bruce Mansfield Plant	165 SR 3016	Shippingport	724-643-5000	250	74.0%	185
P-1	1.6	NNE	Kinder Morgan	2701 Midland Beaver Rd	Industry	724-840-9792	12	41.3%	5
P-1	0.5	E	National Gypsum	168 Shippingport Rd	Shippingport	724-643-3440	44	41.3%	18
P-4	4.6	ENE	Horsehead Corp.	300 Frankfort Rd	Monaca	724-773-9003	521	60.0%	313
P-8	8.2	NE	Beaver County Courthouse	810 3rd St	Beaver	724-728-5700	350	70.0%	245
P-8	8.9	NE	Beaver County Times	400 Fair Ave	Beaver	724-775-3200	120	50.0%	60
P-8	9.6	NE	Col-Fin Specialty Steel Co.	100 Front St	Fallston	724-843-7315	60	41.3%	25
P-8	8.0	NE	Friendship Ridge	246 Friendship Circle	Beaver	724-775-7100	243	41.3%	101
P-8	8.5	NE	Heritage Valley - Beaver	1000 Dutch Ridge Road	Beaver	724-728-7000	41	41.3%	17
P-9	7.0	ENE	AES Beaver Valley	394 Frankfort Rd	Monaca	724-728-9155	54	41.3%	22
P-9	9.3	ENE	Anchor Hocking Specialty Glass Co.	400 9th St	Midland	724-775-0010	70	41.3%	29
P-9	5.4	ENE	BASF Corporation	370 Frankfort Rd	Monaca	724-728-6900	15	41.3%	6
P-9	7.2	ENE	Beaver Valley Mall	570 Beaver Valley Mall Blvd	Monaca	724-774-5573	400	41.3%	166
P-9	7.1	ENE	Community College of Beaver County	One Campus Dr	Monaca	724-775-8561	250	90.0%	225
P-9	9.7	ENE	Datatel	1729 Pennsylvania Ave	Monaca	724-775-5300	20	10.0%	2
P-9	8.0	ENE	Kohl's	97 Wagner Rd	Monaca	724-774-0434	40	41.3%	17
P-9	7.0	ENE	NOVA Chemical	400Frankfort Rd	Monaca	727-774-1000	150	50.0%	75
P-9	8.1	ENE	Penn State - Beaver Campus	100 University Dr	Monaca	724-773-3500	188	41.3%	78
P-9	5.4	ENE	PGT Trucking Inc.	One PGT Way	Monaca	724-728-3500	100	40.0%	40
P-9	8.0	ENE	Target	87 Wagner Rd	Monaca	724-728-7258	50	41.3%	21
P-9	8.6	ENE	Walmart Supercenter	PA Rt 18/ Walmart Plaza Shopping Center	Monaca	724-773-2929	100	41.3%	42

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Employees (max shift)	% Non-EPZ	Employees (Non EPZ)
P-10	9.0	E	Selectrode Industries, Inc.	100 Commerce Way	Aliquippa	631-547-5470	50	41.3%	21
P-10	9.4	ESE	Service Link LP	4000 Industrial Blvd	West Aliquippa	724-857-5890	700	41.3%	290
P-10	10.1	E	United States Gypsum Co	1 Woodlawn Rd	Aliquippa	724-857-4300	145	41.3%	60
						Beaver County Subtotals:	*4,822*	-	*2,518*
COLUMBIANA COUNTY, OH									
O-1	5.4	WNW	The Hall China Company	1 Anna Ave	East Liverpool	330-385-2900	40	38.9%	16
O-2	8.1	W	East Liverpool City Hospital	425 West 5th St	East Liverpool	330-385-7200	124	38.9%	49
O-2	7.1	W	Ergon Inc.	9995 Ohio River Blvd	Newell	301-387-4343	150	38.9%	59
O-3	8.6	ENE	Walmart Supercenter	16280 Dresden Ave	East Liverpool	330-386-9813	100	38.9%	39
						Columbiana County Subtotals:	*414*	-	*163*
HANCOCK COUNTY, WV									
W-1	10.3	W	Bellofram Co.	8019 Ohio River Blvd	Newell	304-387-1200	375	56.6%	212
W-1	9.2	W	The Homer Laughlin China Company	672 Fiesta Dr	Newell	304-387-1300	600	56.6%	340
W-1	6.2	W	The Orchard at Fox Crest	125 Fox Ln	Chester	304-387-0101	55	56.6%	32
						Hancock County Subtotals:	*1,030*	-	*584*
						TOTAL:	**6,266**	-	**3,265**

Table E-4. Recreational Areas within the EPZ

Sub-Area	Distance (miles)	Direction	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
BEAVER COUNTY, PA								
P-1	1.3	NW	Lincoln Park Performing Arts Center	1 Lincoln Park	Midland	724-643-9004	750	313
P-2	3.9	NNW	State Gamelands No 173	N/A	Industry	717-787-4250	778	324
P-7	5.2	N	Orchard Grove Campsites	6138 Tuscarawas Rd	Industry	724-495-7828	9	4
P-8	9.2	NE	Bridgewater Landings Marina	404 Brkich Way	Beaver	724-728-2880	39	32
P-8	9.1	ENE	Captain's Quarters Marina	101 Wolfe Ln	Beaver	724-728-3891	44	18
P-8	9.3	NE	Jeffries Landing	1440 Riverside Dr	Beaver	724-728-7878	15	10
P-8	9.3	NE	River Harbour	Pennsylvania 51	Beaver	724-775-3010	5	4
P-8	8.9	NNE	Brady's Run County Park	526 Bradys Run Rd	Beaver Falls	724-770-2060	300	200
P-9	7.1	ENE	Community College of Beaver County	One Campus Dr	Monaca	724-775-8561	2,800	1,112
P-9	8.1	ENE	Penn State - Beaver Campus	100 University Dr	Monaca	724-773-3500	870	346
P-11	7.6	SSE	State Gamelands No 189	189 Allison Rd	Clinton	717-787-4250	304	127
P-12	8.2	SSW	Linsly Outdoor Center	2425 Pennsylvania Ave	Georgetown	724-899-2100	50	20
P-12	6.7	SSE	Promise Camp & Conference Center	227 Lance Rd	Clinton	724-899-2402	150	50
P-12	7.2	S	Raccoon State Park	3000 State Route 18	Hookstown	724-899-2200	1,000	600
						Beaver County Subtotals:	*7,114*	*3,160*
COLUMBIANA COUNTY, OH								
O-2	7.6	W	Kent State University	400 East 4th St	East Liverpool	330-385-3805	1,400	524
						Columbiana County Subtotals:	*1,400*	*524*
HANCOCK COUNTY, WV								
W-1	9.9	W	Kennedy Marina & Campground	110 Kennedy Marina Park Rd	Newell	304-387-3063	664	248
W-1	7.4	W	Smith's Landing Campground	163 Ferry Road	Chester	304-552-2918	25	24
W-2	9.3	SW	Tomlinson Run State Park	84 Osage Rd	Grant	304-564-3651	400	339
						Hancock County Subtotals:	*1,089*	*611*
						TOTAL:	**9,603**	**4,295**

Table E-5. Golf Courses within the EPZ

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
BEAVER COUNTY, PA								
P-3	3.4	NE	Deer Trails Country Club	311 Engle Rd	Industry	724-643-4710	92	38
P-3	3.2	N	Rivers Edge Golf Club	1326 Ohio View Dr	Industry	724-643-4110	5	5
P-7	9.7	N	Black Hawk Golf Course	644 Blackhawk Road	Beaver Falls	724-843-5512	360	150
P-7	8.5	NE	Rolling Acres Golf Course	350 Anchortown Rd	Beaver Falls	724-843-6736	180	75
P-8	9.4	E	Beaver Valley Golf Club	725 6th Ave	Beaver Falls	724-846-2211	137	57
P-9	6.9	E	Ironwood Golf Center	3036 Broadhead Rd	Aliquippa	724-378-6600	15	11
P-10	7.2	S	Club at Shadow Lakes	2000 Beaver Lakes Blvd	West Aliquippa	724-375-5511	60	30
P-12	9.8	S	Ponderosa Golf Course	2728 Pennsylvania 168	Hookstown	724-947-4745	128	53
						Beaver County Subtotals:	*977*	*419*
COLUMBIANA COUNTY, OH								
O-3	8.2	NW	Turkana Golf Course	14678 Ohio 170	East Liverpool	330-382-1187	19	10
						Columbiana County Subtotals:	*19*	*10*
HANCOCK COUNTY, WV								
W-3	6.9	SW	Pleasant Hill Golf Course	723 Pleasant Hill Rd	New Manchester	304-387-0068	20	12
						Hancock County Subtotals:	*20*	*12*
						TOTAL:	**1,016**	**441**

Table E-6. Lodging Facilities within the EPZ

Sub-Area	Distance (miles)	Direc-tion	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
BEAVER COUNTY, PA								
P-3	2.7	NE	Willows Inn	1830 Midland Beaver Rd	Industry	724-643-4500	58	58
P-8	7.8	NE	Felicity Farms Bed & Breakfast	2075 Dutch Ridge Rd	Beaver	724-775-0735	8	4
P-9	7.5	ENE	Comfort Suites	1523 Old Broadhead Rd	Monaca	724-728-9480	78	39
P-9	7.1	ENE	Hampton Inn	202 Fairview Dr	Monaca	724-774-5580	86	86
P-9	7.3	ENE	Holiday Inn Express Hotel & Suites	105 Stone Quarry Rd	Monaca	724-728-5121	58	46
						Beaver County Subtotals:	*288*	*233*
COLUMBIANA COUNTY, OH								
O-2	8.2	WNW	East Liverpool Motor Lodge	2340 Dresden Ave	East Liverpool	330-386-5858	150	100
O-2	6.4	W	Granny's Shanty B & B	921 Ohio Ave	East Liverpool	330-385-7722	4	2
O-2	7.8	W	Sturgis House	122 West 5th St	East Liverpool	304-387-8000	18	12
O-2	8.4	W	Vista Motel	721 Edwards St	East Liverpool	330-385-2881	22	22
O-3	8.2	WNW	Comfort Inn	15860 St. Clair Ave	East Liverpool	330-386-3800	132	66
						Columbiana County Subtotals:	*326*	*202*
HANCOCK COUNTY, WV								
W-1	7.6	W	Andrews Inn Town Motel	411 Chester Newell Rd	Chester	304-387-2800	48	48
W-1	9.5	W	Holiday Inn Express Hotel	1181 Washington St	Newell	304-740-2300	150	100
						Hancock County Subtotals:	*198*	*148*
						TOTAL:	**812**	**583**

Table E-7. Correctional Facility within the EPZ

Sub-Area	Distance (miles)	Direction	Facility Name	Street Address	Municipality	Phone	Capacity
BEAVER COUNTY, PA							
P-10	10.2	E	Beaver County Jail	6000 Woodlawn Rd # 2	West Aliquippa	724-378-8177	300
						Beaver County Subtotal:	*300*
						TOTAL:	**300**

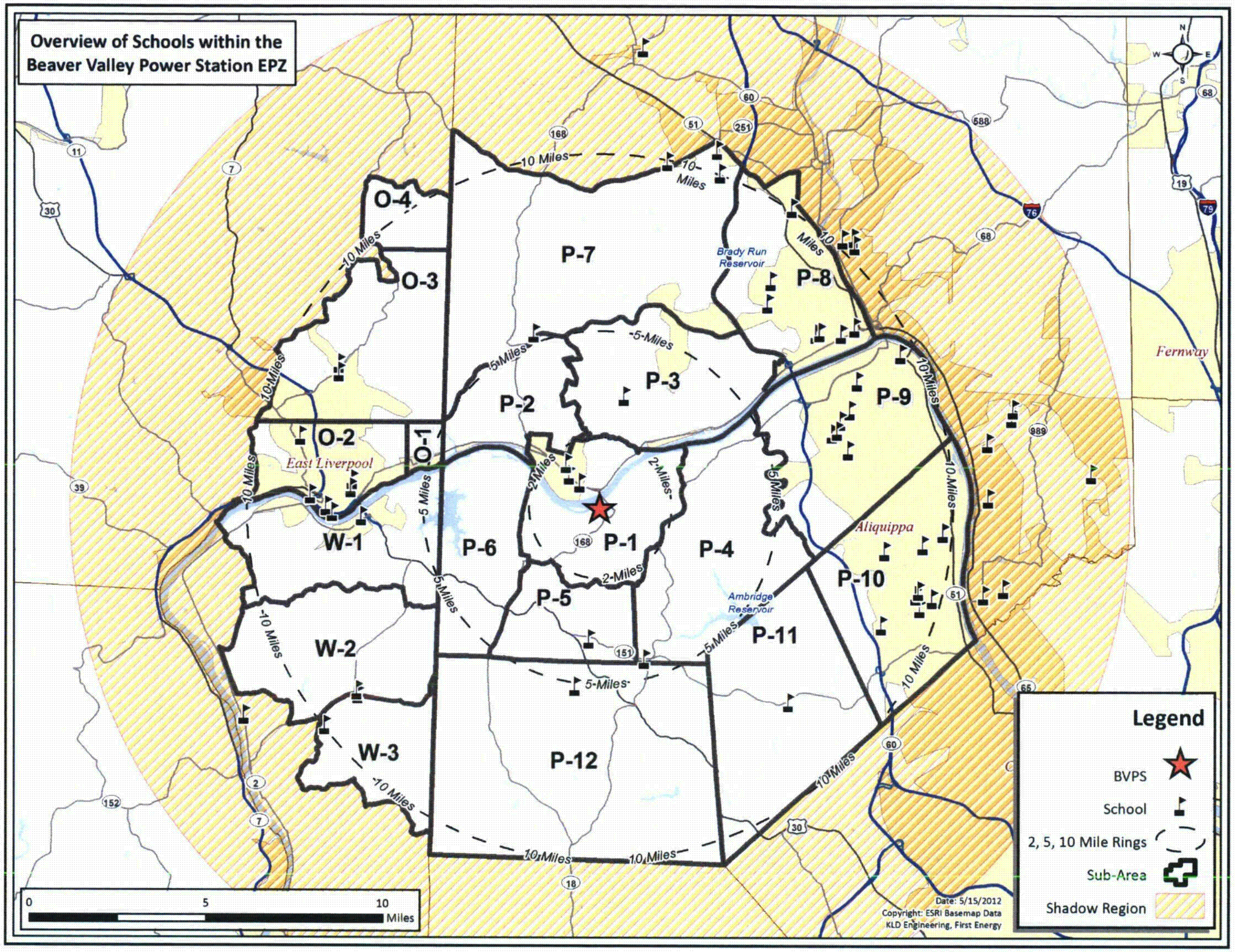
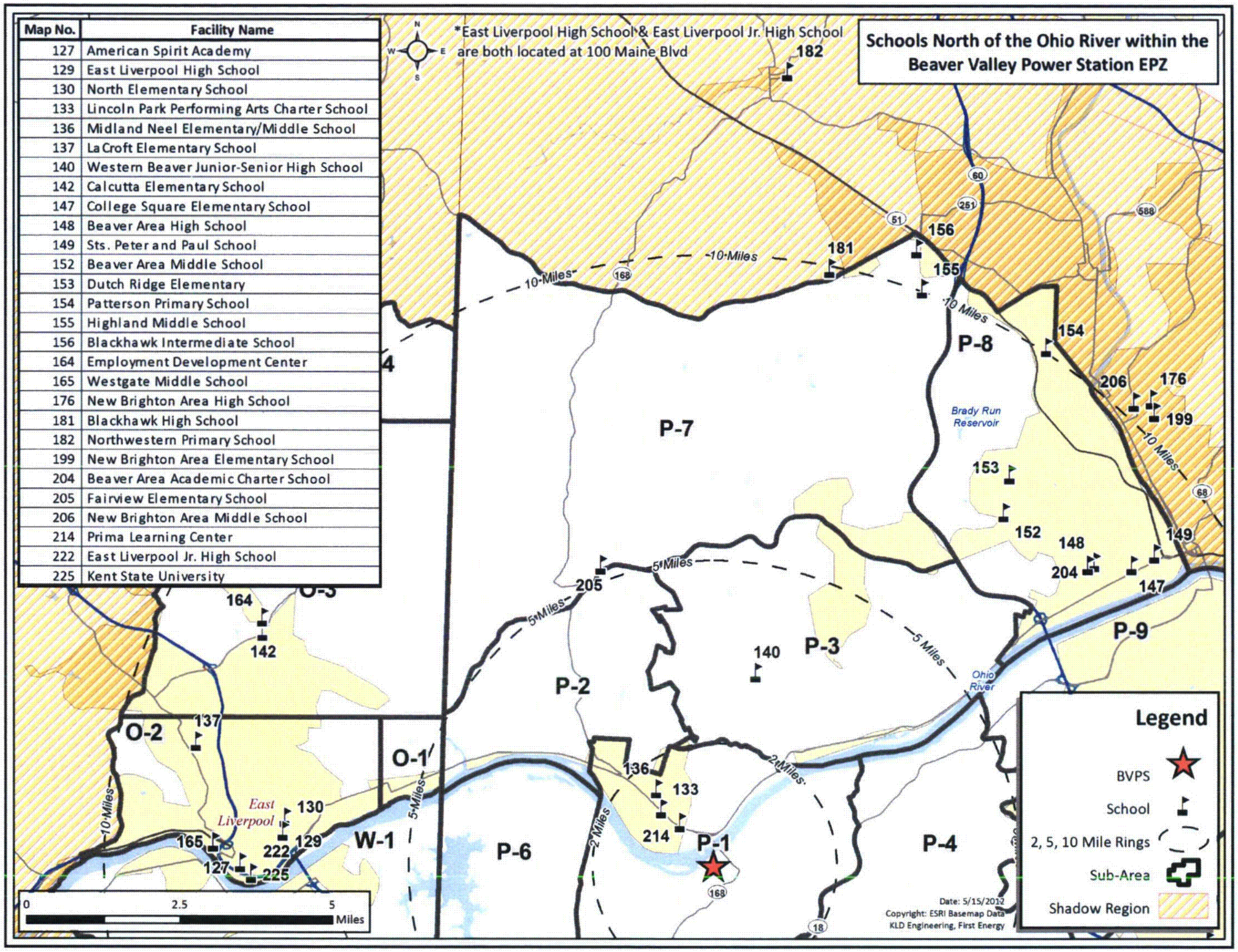
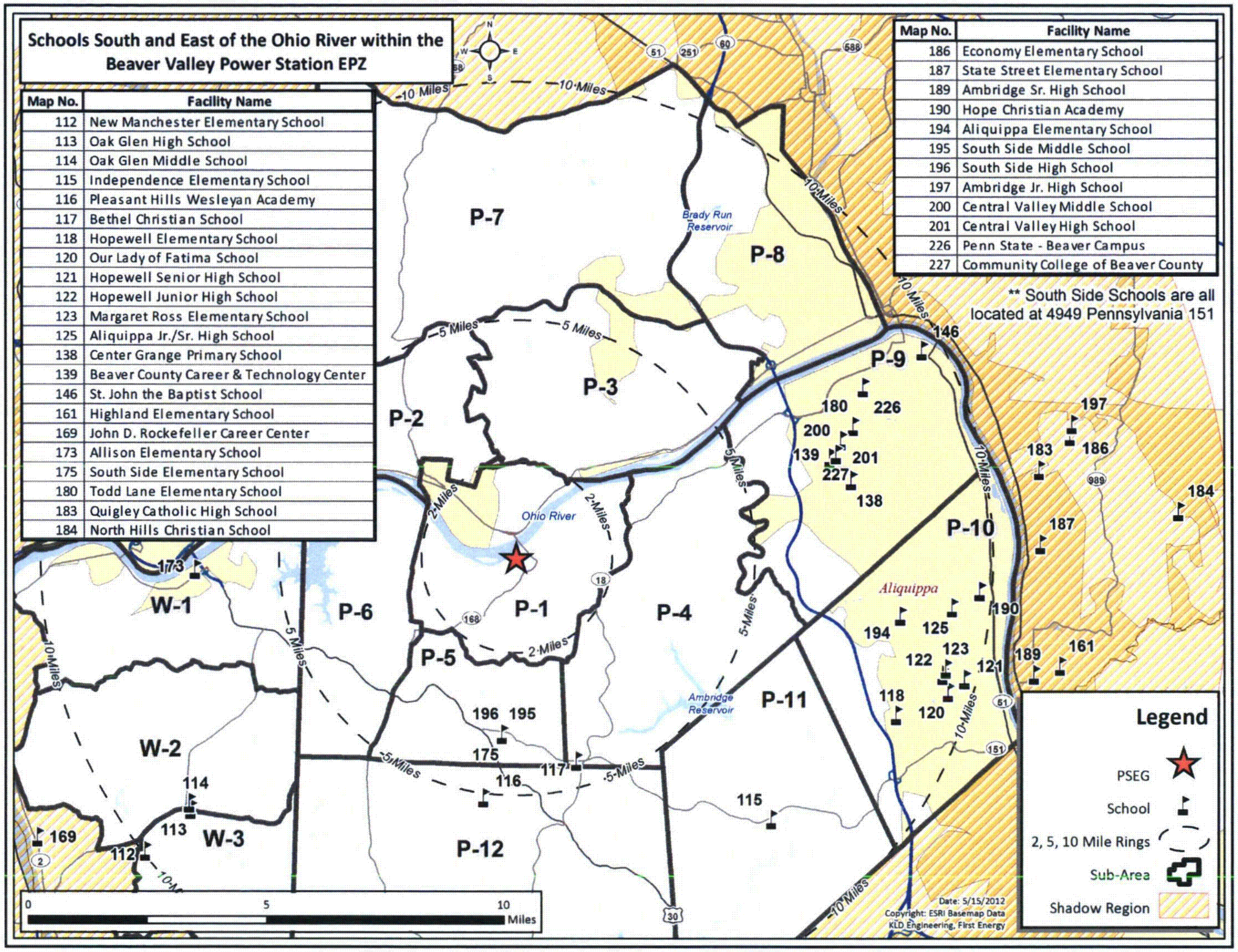


Figure E-1. Schools within the EPZ - Overview



Map No.	Facility Name
127	American Spirit Academy
129	East Liverpool High School
130	North Elementary School
133	Lincoln Park Performing Arts Charter School
136	Midland Neel Elementary/Middle School
137	LaCroft Elementary School
140	Western Beaver Junior-Senior High School
142	Calcutta Elementary School
147	College Square Elementary School
148	Beaver Area High School
149	Sts. Peter and Paul School
152	Beaver Area Middle School
153	Dutch Ridge Elementary
154	Patterson Primary School
155	Highland Middle School
156	Blackhawk Intermediate School
164	Employment Development Center
165	Westgate Middle School
176	New Brighton Area High School
181	Blackhawk High School
182	Northwestern Primary School
199	New Brighton Area Elementary School
204	Beaver Area Academic Charter School
205	Fairview Elementary School
206	New Brighton Area Middle School
214	Prima Learning Center
222	East Liverpool Jr. High School
225	Kent State University

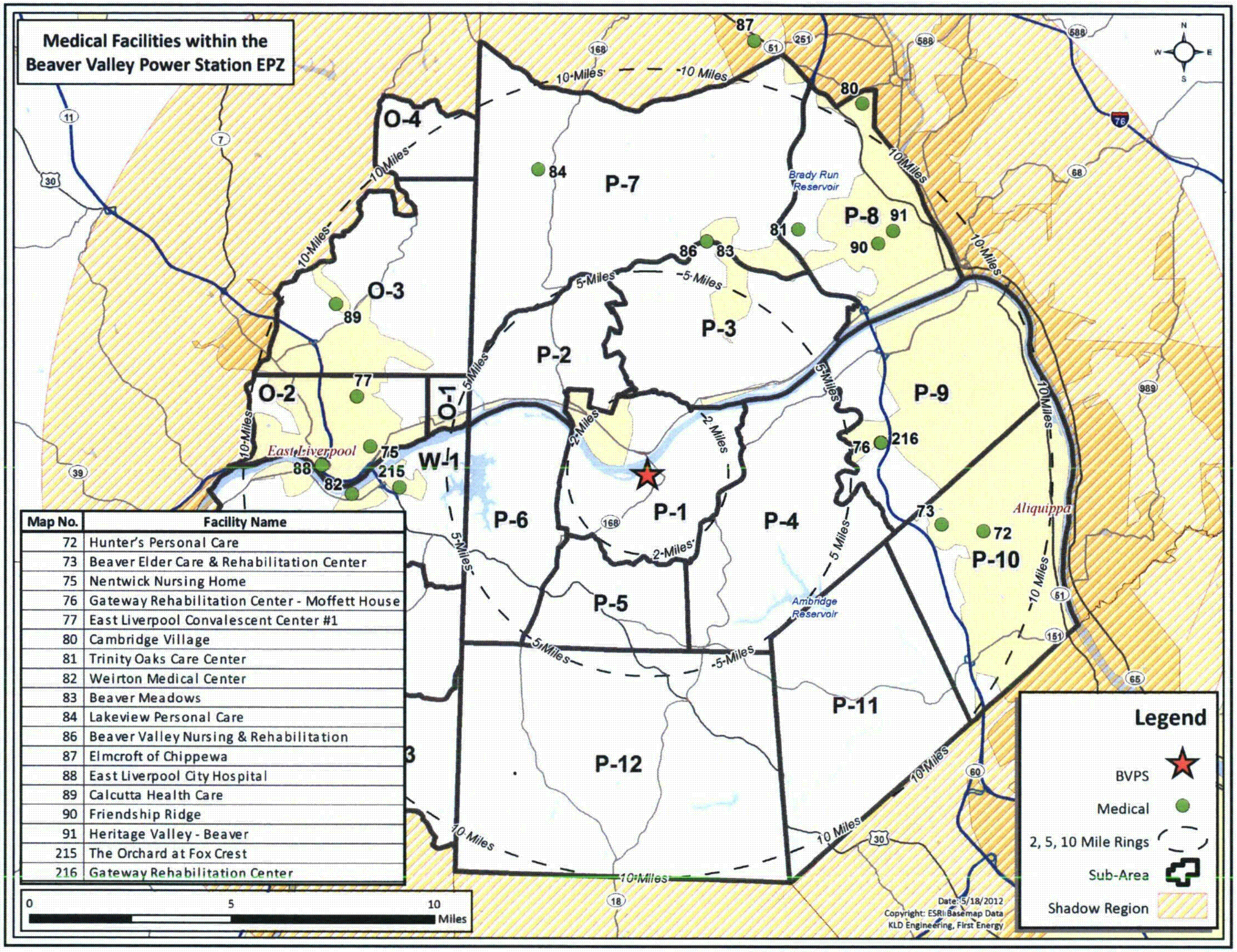
Figure E-2. Schools North of the Ohio River within the EPZ



Map No.	Facility Name
112	New Manchester Elementary School
113	Oak Glen High School
114	Oak Glen Middle School
115	Independence Elementary School
116	Pleasant Hills Wesleyan Academy
117	Bethel Christian School
118	Hopewell Elementary School
120	Our Lady of Fatima School
121	Hopewell Senior High School
122	Hopewell Junior High School
123	Margaret Ross Elementary School
125	Aliquippa Jr./Sr. High School
138	Center Grange Primary School
139	Beaver County Career & Technology Center
146	St. John the Baptist School
161	Highland Elementary School
169	John D. Rockefeller Career Center
173	Allison Elementary School
175	South Side Elementary School
180	Todd Lane Elementary School
183	Quigley Catholic High School
184	North Hills Christian School

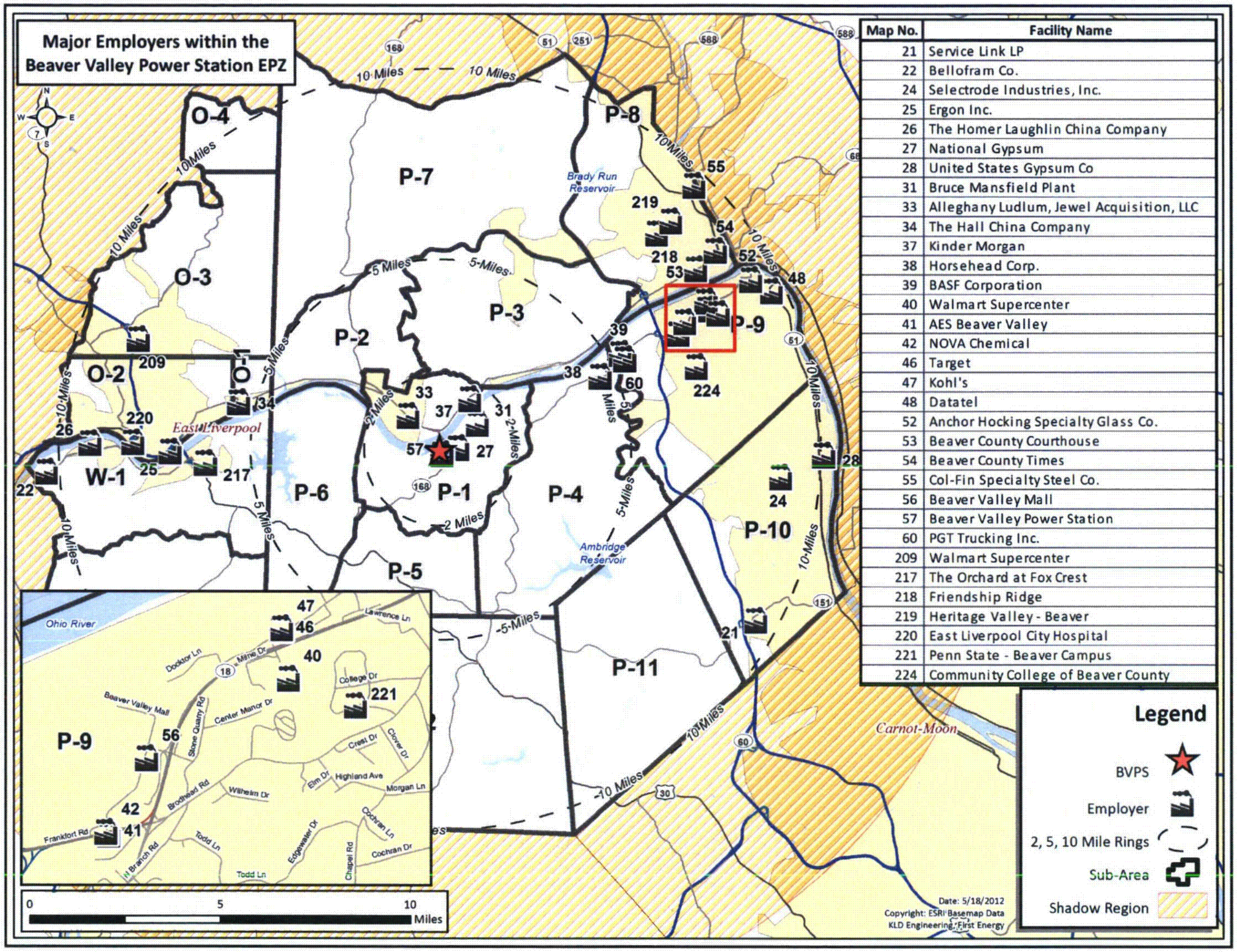
Map No.	Facility Name
186	Economy Elementary School
187	State Street Elementary School
189	Ambridge Sr. High School
190	Hope Christian Academy
194	Aliquippa Elementary School
195	South Side Middle School
196	South Side High School
197	Ambridge Jr. High School
200	Central Valley Middle School
201	Central Valley High School
226	Penn State - Beaver Campus
227	Community College of Beaver County

Figure E-3. Schools South of the Ohio River within the EPZ



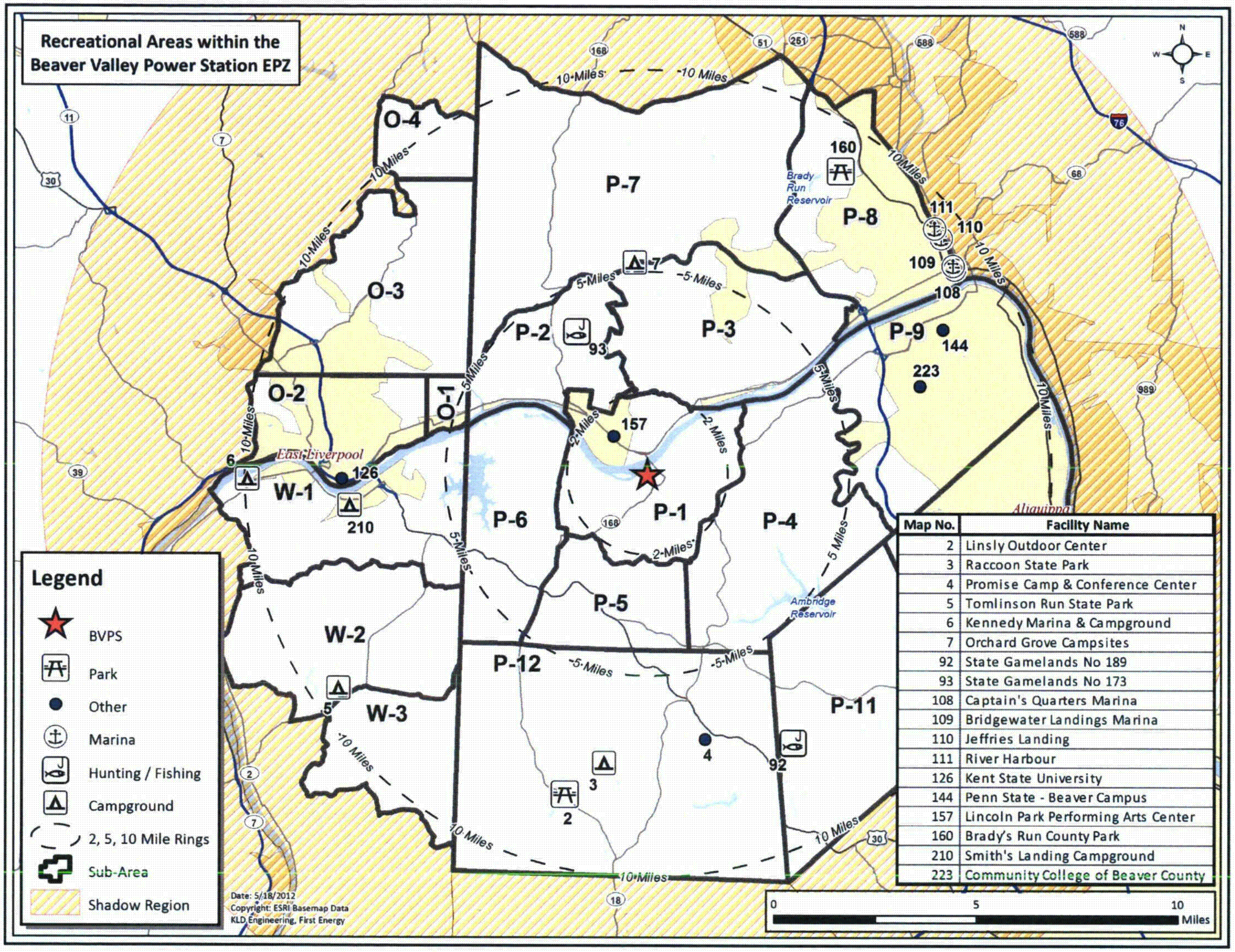
Map No.	Facility Name
72	Hunter's Personal Care
73	Beaver Elder Care & Rehabilitation Center
75	Nentwick Nursing Home
76	Gateway Rehabilitation Center - Moffett House
77	East Liverpool Convalescent Center #1
80	Cambridge Village
81	Trinity Oaks Care Center
82	Weirton Medical Center
83	Beaver Meadows
84	Lakeview Personal Care
86	Beaver Valley Nursing & Rehabilitation
87	Elmcroft of Chippewa
88	East Liverpool City Hospital
89	Calcutta Health Care
90	Friendship Ridge
91	Heritage Valley - Beaver
215	The Orchard at Fox Crest
216	Gateway Rehabilitation Center

Figure E-4. Medical Facilities within the EPZ



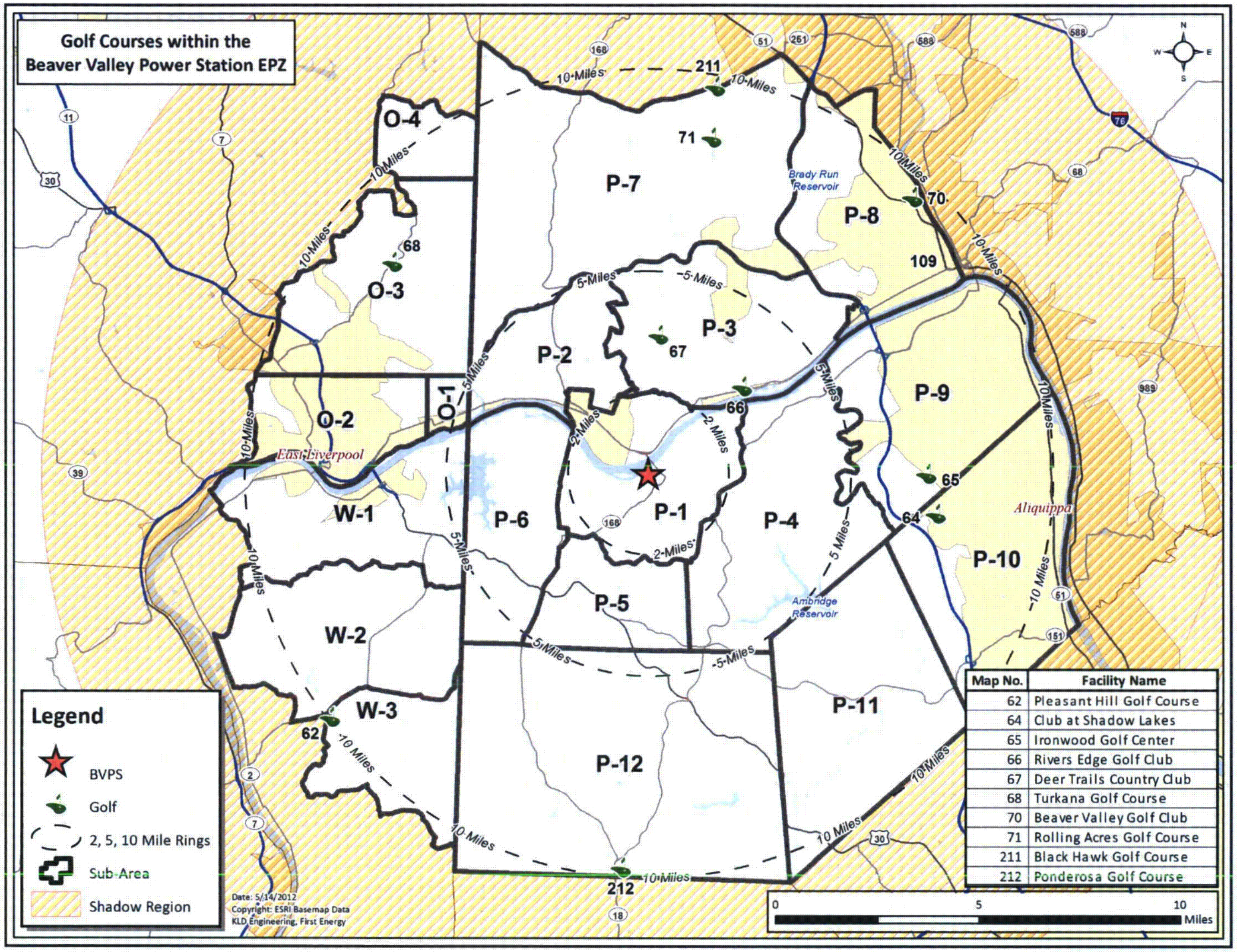
Map No.	Facility Name
21	Service Link LP
22	Bellofram Co.
24	Selectrode Industries, Inc.
25	Ergon Inc.
26	The Homer Laughlin China Company
27	National Gypsum
28	United States Gypsum Co
31	Bruce Mansfield Plant
33	Alleghany Ludlum, Jewel Acquisition, LLC
34	The Hall China Company
37	Kinder Morgan
38	Horsehead Corp.
39	BASF Corporation
40	Walmart Supercenter
41	AES Beaver Valley
42	NOVA Chemical
46	Target
47	Kohl's
48	Datatel
52	Anchor Hocking Specialty Glass Co.
53	Beaver County Courthouse
54	Beaver County Times
55	Col-Fin Specialty Steel Co.
56	Beaver Valley Mall
57	Beaver Valley Power Station
60	PGT Trucking Inc.
209	Walmart Supercenter
217	The Orchard at Fox Crest
218	Friendship Ridge
219	Heritage Valley - Beaver
220	East Liverpool City Hospital
221	Penn State - Beaver Campus
224	Community College of Beaver County

Figure E-5. Major Employers within the EPZ



Map No.	Facility Name
2	Linsly Outdoor Center
3	Raccoon State Park
4	Promise Camp & Conference Center
5	Tomlinson Run State Park
6	Kennedy Marina & Campground
7	Orchard Grove Campsites
92	State Gamelands No 189
93	State Gamelands No 173
108	Captain's Quarters Marina
109	Bridgewater Landings Marina
110	Jeffries Landing
111	River Harbour
126	Kent State University
144	Penn State - Beaver Campus
157	Lincoln Park Performing Arts Center
160	Brady's Run County Park
210	Smith's Landing Campground
223	Community College of Beaver County

Figure E-6. Recreational Areas within the EPZ



Map No.	Facility Name
62	Pleasant Hill Golf Course
64	Club at Shadow Lakes
65	Ironwood Golf Center
66	Rivers Edge Golf Club
67	Deer Trails Country Club
68	Turkana Golf Course
70	Beaver Valley Golf Club
71	Rolling Acres Golf Course
211	Black Hawk Golf Course
212	Ponderosa Golf Course

Figure E-7. Golf Courses within the EPZ

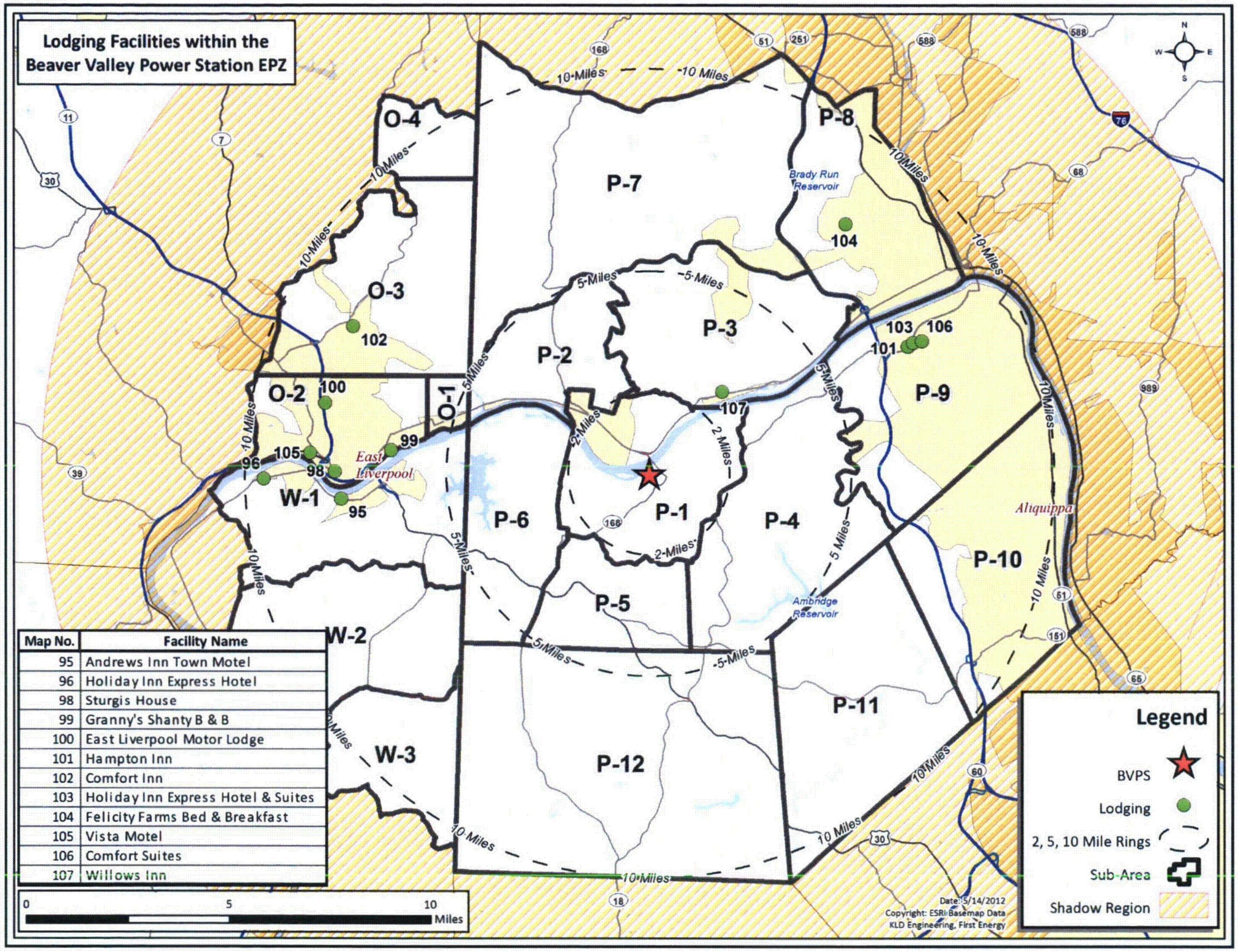


Figure E-8. Lodging Facilities within the EPZ

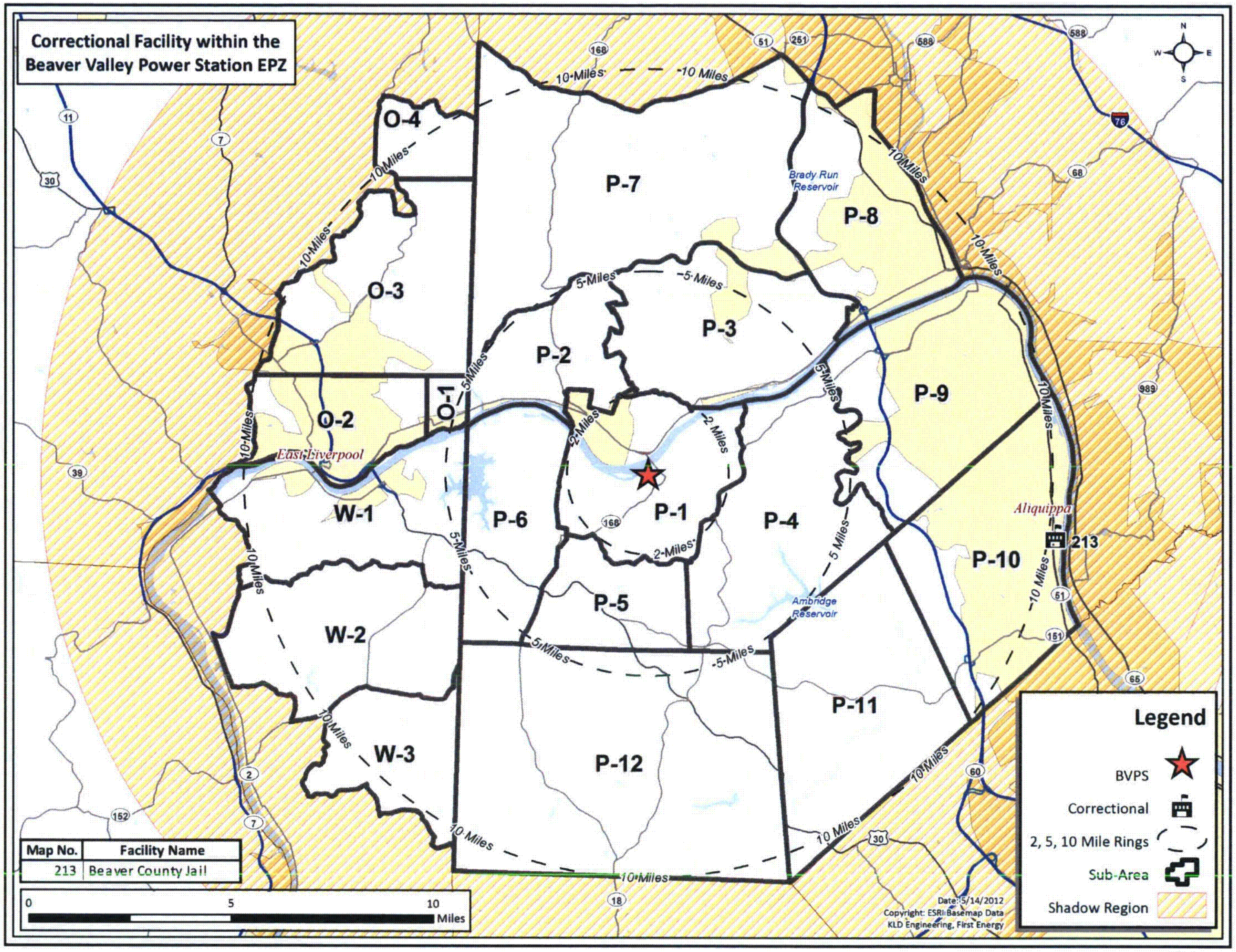


Figure E-9. Correctional Facility within the EPZ