Dier-ez-Zor Civil Council engineers and U.S. Army Special Operations Command team members finish installation of discharge pipes February 2019 at Pumping Station #1 on the Euphrates River in Syria. (Photo by project engineer)

Refilling the Suwar Canal

An Irregular Warfare Case Study in Infrastructure Effects

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After decades of kinetic action, the general public is unlikely to associate special operations forces (SOF) with the seemingly plodding work of infrastructure projects. This natural tendency is reinforced in part by a heavy direct-action emphasis in SOF branding and marketing.[1] However, Army doctrine states that these forces are well suited for humanitarian efforts and noncombat projects due to their adaptability, rapid deployability, and effectiveness in austere environments. SOF can bring to bear "their geographic orientation, cultural knowledge, language capabilities, and their ability to work with local, ethnic groups and civilian populations" to be uniquely effective in information gathering and in project execution.[2] SOF has a history of leveraging infrastructure in innovative ways to achieve meaningful effects in competition and conflict. The campaign against the Islamic State (IS), known as Operation Inherent Resolve (OIR), led by SOF and executed "by, with, and through" local partners, provided multiple opportunities for SOF to exhibit problem-solving capabilities alongside its tactical prowess.[3] One such instance was born of a simultaneous humanitarian and tactical requirement during the southward pursuit of IS in central-eastern Syria. Engineers and logisticians in the U.S. Army Special Operations Command (USASOC) partnered with local civil authorities to address an inoperable canal in the mid-Euphrates River Valley in 2018–2019. The expedient bypass repair of destroyed pump stations on the Suwar Canal and the resultant easing of resource strain on both civilian populations and partner forces provides insights useful for niche use of SOF in competition and in conflict. The project highlighted the need for highly enabled SOF-aligned engineers and logisticians and demonstrates the potential of using nonstandard infrastructure as a vector for humanitarian, information, and tactical effects.

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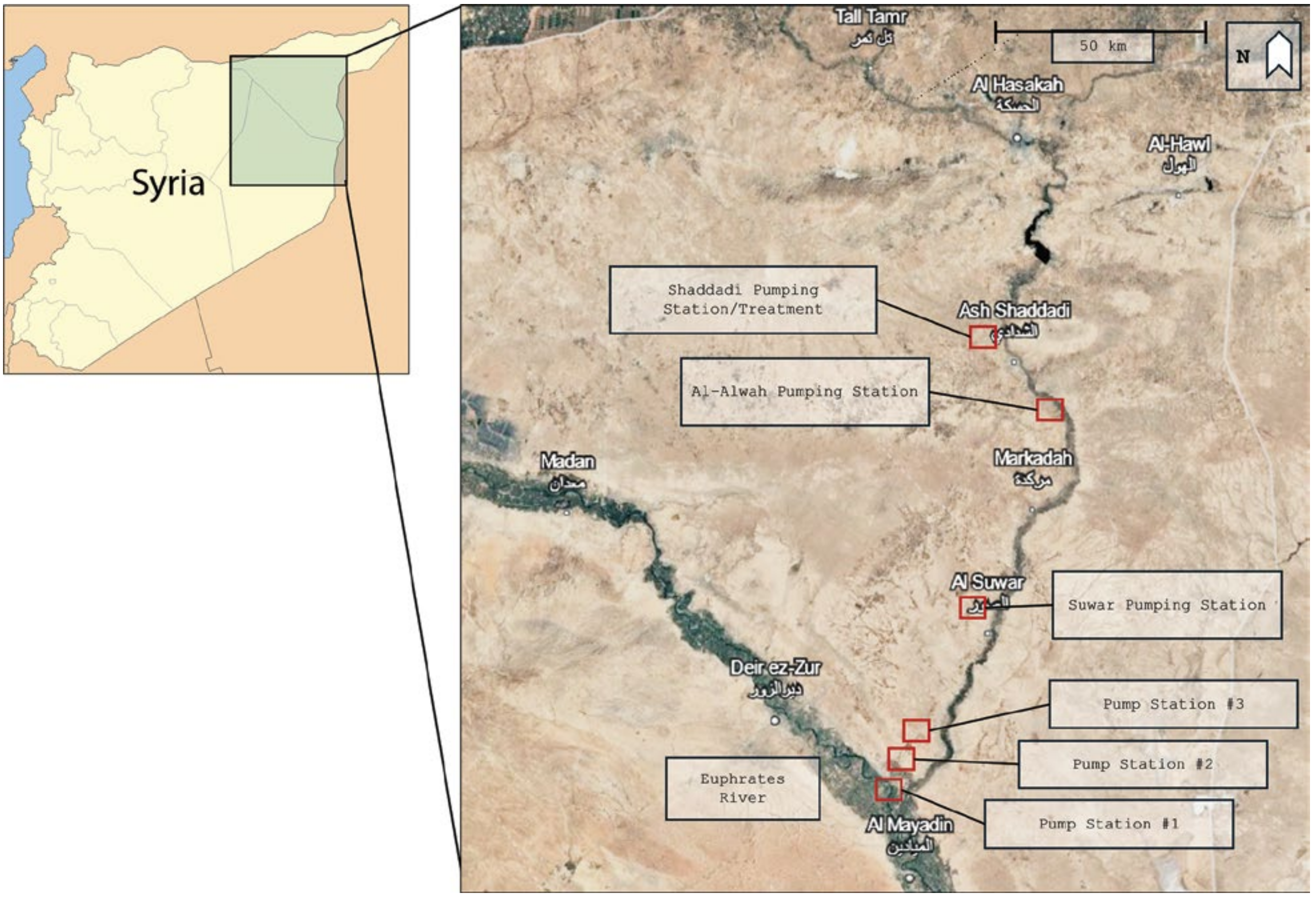
Birth and Destruction of the Sabha-Suwar Canal

Located in south-central Syria, the Sabha-Suwar Canal was developed in the 1980s as a component of the Khaor River Basin Project. The project was designed to transform nearly six hundred square miles of Syrian desert into arable land for agriculture. The canal originates on the Euphrates River at the Al Sabha Pumping Station, and flows approximately 42 km northeast, terminating at a booster station for onward transmission in its namesake city of Suwar. The canal once served both irrigation and water lines providing water to anywhere from seventy thousand to three hundred thousand Syrians. The Al Sabha Pumping Station also historically powered the nearby Sahil Canal, which, according to indigenous engineers and civil council liaisons, delivered irrigation water to an additional two hundred thousand people in the mid-Euphrates River Valley (MERV).[4]

The 2013–2014 proliferation of IS saw rapid expansion of the group's physically occupied territory and of their influence over indigenous populations.[5] From 2014 until late 2017, IS manipulated the water architecture of the Khaor River Valley as means of population and resource control. As Syrian Democratic Forces (SDF) moved southward across the MERV in 2017 and 2018, retreating IS forces severely damaged or destroyed pumping stations, canal framework, and power sources servicing the canal. As a result, thousands of acres in a region heavily reliant on agriculture revenue were left barren, and locals faced intermittent access to drinking water. SDF occupied and retained the facilities following their liberation from IS, building outposts



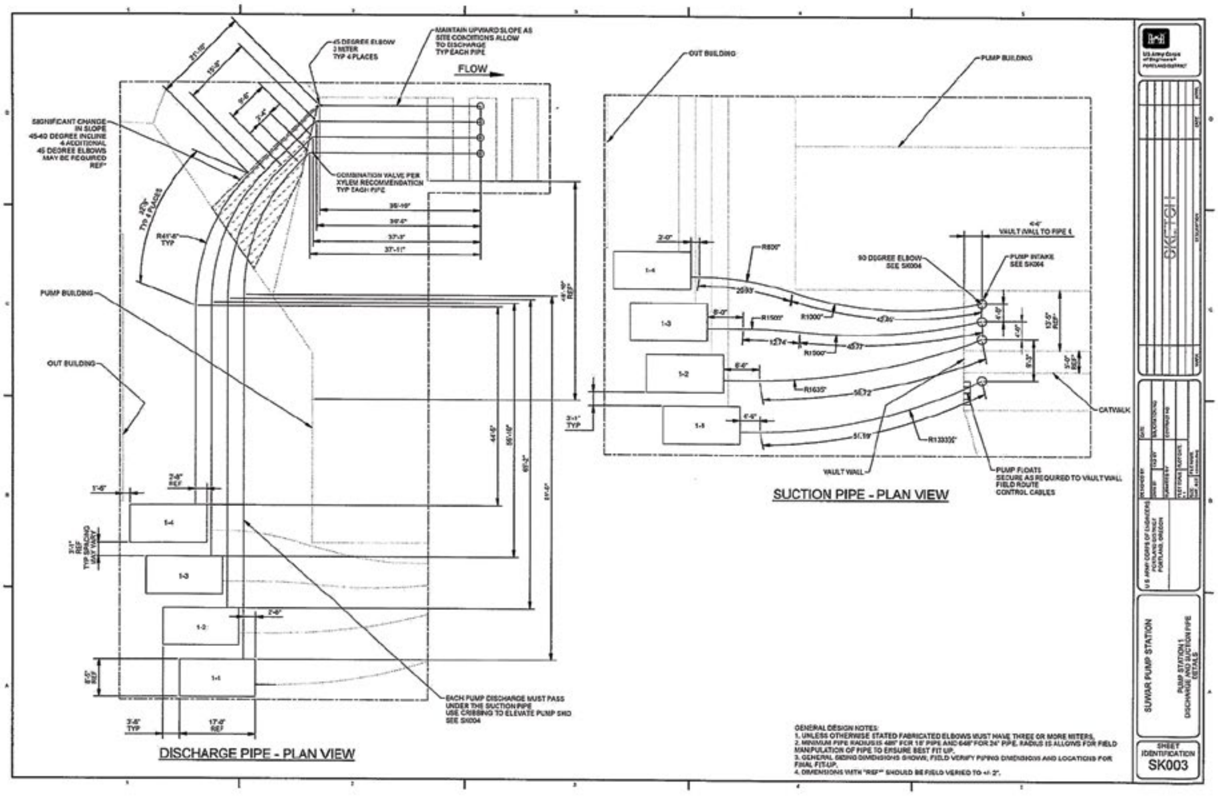
The Suwar Canal originates on the Euphrates River at the Al Sabha Pumping Station and flows approximately 42 km northeast, terminating at a booster station for onward transmission in its namesake city of Suwar. (Photo provided to author by project engineer)

near the key terrain. Bridge repairs and rubble removal, mostly by local civil councils, laid the groundwork for eventually restoring services to the region. However, the cost and effort required to restore the canal system to initial operating capability, particularly in a semipermissive security environment, were uncertain.[6]

In mid-2018, prospective repair of the Suwar Canal represented an unlikely convergence of unique SOF permissions, authorities, and military necessity that set it apart from other less-suitable projects. Lack of basic services in the region not only imposed hardship on the civilian populace but also significant sustainment strain on partner forces. The same SDF pursuing IS in the MERV relied on costly and inefficient means of procuring their own water and were dedicating valuable manpower to distributing water among locals via tanker trucks. These sustainment challenges introduced friction to an already-complex operation. In late 2017, then Secretary of Defense James Mattis had anticipated "shifting from an offensive terrain-seizing approach to a stabilizing effort," including "helping civil authorities set up water and electrical systems."[7] In keeping with the secretary's remarks, and based on the significance of the canal to both the humanitarian and tactical situation in the MERV, SOF leaders ordered an infrastructure assessment shortly after the region was reclaimed by SDF in early 2018.[8]

Infrastructure Assessment and Defining the Problem

USASOC engineers and Civil Affairs Team (CAT) 612 conducted a deliberate assessment of canal infrastructure in summer of 2018 from its origin near the town of Deir-ez-Zor on the east bank of the Euphrates River to the third downstream pumping station approximately eight kilometers from the Al Sabha. The team determined that the actual channel of the canal was largely unharmed. The open channel sections had



A sample engineering diagram for the layout of pumps, intake, and discharge pipes at Pumping Station #2. Detailed site planning was essential to navigating the spatial specifics of each distinct site. (Scan of document from U.S. Army Corps of Engineers, Portland District)

been cleared of rubble and otherwise remediated by indigenous forces shortly after seizing the terrain. A milelong underground pressurized pipeline following Station #2 remained uncleared due to fears of explosive hazards, but surface damage was not observed.[9] Assessment was thus focused on the pump stations, where both the complex equipment and the damage were centralized. The resultant report spanned nearly fifty pages, evaluating damage and serviceability of key equipment across the canal's three pumping stations as well as additional infrastructure descended from underground pipelines past the Suwar Pumping Station.

In short, the state of major infrastructure ranged from "poor" to "beyond repair." One pump station had been destroyed by coalition airstrikes. Complex, vital systems at each of the stations—pumps, electrical systems, controllers, storage tanks, filtration systems, sedimentation systems, chlorination equipment, and more—had been severely damaged in the IS withdrawal. Of what remained, parts, equipment, cabling, and materials had seemingly been stripped from the facilities by struggling locals thereafter. The report was cautious about the prospects of anything less than a complete reconstruction, hedging that "small, hasty bypasses may be made with portable pumps across the pumping stations, but may not create enough flow or velocity to overcome the hydraulic grade increase [across the canal's cross-section]."[10]

Despite the report's pessimism on the success of temporary fixes, USASOC engineers began to analyze potential solutions or mitigations to bridge the time and fiscal gap until Department of State or other agencies could take on a comprehensive repair. Potential courses of action were screened and evaluated based on feasibility, longevity, cost, and speed of execution. The most intensive solution, a complete repair of the organic infrastructure, was quickly discarded as outside the scope of SOF. The assessment team, unable to make productive contact with the original equipment manufacturers, estimated that the in-depth redesign of facilities and installation of complex electrical systems, computer systems, and bespoke pump equipment would "require significant reconstruction efforts that [would] take years to complete … the reconstruction and repairs of all stations will easily exceed $100 million USD."[11] Instead, the USASOC team devoted efforts to, on its face, the most obvious solution: routing water around the damaged pump stations, rather than through them.

Developing Options and Specialty Procurement

The nature of the budding project (outside the scope of typical troop construction, and at the intersection of "public works" and partner force sustainment) complicated the search for a suitable funding source. The U.S. Agency for International Development (USAID) funded various projects throughout Syria during the opening years of OIR, but the March 2018 funding freeze on Syria stabilization efforts precluded the initiation of any new, major projects. USAID had, in fact, explored the possibility of funding mitigation measures to the canal, but the projected cost of a true fix exceeded the agency's entire annual budget for Syria stabilization, all of which had been allocated for the year.[12] Instead, the USASOC team would focus on requesting military funds, exploring programs like the Department of Defense's (DOD) Overseas Humanitarian Disaster and Civic Aid among other potentially appropriate sources.

Timely request and approval of any funds would rely on the expertise of a multifunctional logistics team, including USASOC lawyers, contracting officers, logisticians, and engineers. In addition, the proposed project would need both a strong engineering backbone and a genuine tactical justification to withstand scrutiny at requirements review boards. For the latter, the logistics benefit of relieving sustainment strain on dispersed partner forces fighting a determined enemy provided a meaningful tactical rationale. To ensure the technical aspects of the project were as thoroughly considered, the USASOC team looked to the broader DOD enterprise for planning assistance.

The broad strokes of a technical solution—an auxiliary system to move water around the damaged permanent pump stations—had taken shape by late summer of 2018. Developing site layouts and bills of material based on pump placement and pipe joinery called for intensive, detail-oriented design. In order to hasten the design process (and, in turn, the formal funding request), USASOC partnered with the U.S. Army Corps of Engineers (USACE) Portland District for site planning. The USASOC team provided a basic concept of the bypass configuration, expected throughput, and other metrics to help guide the design. Portland District returned with a series of site layout sheets, illustrating the expected cut lengths, angles, and supports required to match the particular geometry of each pump station. The concurrent development of these detailed plans with USASOC's efforts trimmed substantial time off the project's early stages, enabling a faster transition to procurement and execution.

As site plans crystalized into more definitive specifications, USASOC engineers and logisticians cast a wide net in search of specialty equipment that could support the unique project requirements. To achieve a fluid throughput comparable to that of the organic infrastructure, from a river basin well below the ground level of Pump Station #1, would require pumps capable of generating immense pressures (total suction head and discharge head), and pipes capable of withstanding those pressures.[13] To replicate the canal system's intended throughput, the bypass at each pumping station would need to move roughly eighty thousand gallons of water per minute, balancing the canal at 33.6 million gallons per day. Adding to the technical complexity of the problem, pumps had to be sourced with components that did not meet current Environmental Protection Agency emissions guidelines, as emissions control fluid would be difficult to sustainably procure in theater, as would the expertise to work on emissions-controlled equipment (which generally requires factory service representatives).

The intended project timeline and constrained budget precluded custom-built pumps, which would otherwise have been the most effective way to achieve the high throughput requirement. Instead, the team used mine dewatering pumps as a starting point to narrow their search to a handful of commercial vendors with similar tech. Representatives of the USASOC team visited vendor test sites to examine the pumps, confirm planning assumptions, and gain platform-specific technical expertise. After a choosing a vendor, a subsequent training-focused visit ensured each member of the team understood the installation and operation of the large, complex machines. Accounting for maintenance downtime and fueling time, each pumping station would require four of the selected pumps, with three running for eight hours a day. To improve system longevity, the team was able to establish and order a bill of material for three years of maintenance on each pump, as well as maintenance manuals in English, Arabic, and French.

While pumps were sourced domestically, the large volume of required pipe all but prohibited U.S. sourcing, given the cost of shipping materials. Instead, the USASOC team worked alongside Kurdish contractors to seek out and procure a sufficient quantity of pipe, as well as a unique "fusion-welding" tool for both cutting and joining large-diameter, deep thickness high-density polyethylene pipe. The team gathered enough pipe for a bypass at the first pump station, with the intent of executing one mission to determine viability before additional procurement. The USASOC team also procured locally built diesel fuel shipping container tanks with a built in pump-and-hose system to supplement the fuel storage organic to the pumps (five hundred gallons for approximately sixteen hours of run time). This additional fuel option would provide local partners, the Deir-ez-Zor Civil Council (DCC), with fuel stability to maintain canal balance.

Installing the Bypass

With pumps successfully shipped to Iraq and the remaining tools and components procured through various area contractors and staged for local shipping, the USASOC team moved personnel and supplies to a forward staging area in eastern Syria. From there, the team, its security element, and local contractors hauling trucks of heavy equipment and construction materials traveled to Pump Station #1 on the Euphrates in early January 2019.

Security on the project site was a concern. The east bank of the Euphrates was under tenuous partner-force control, but the site was unavoidably close to a major thoroughfare in the town of Deir-ez-Zor. The USASOC element, even when reinforced by a small partner-force squad, settled for a porous set of security positions. Across the river to the west, a Syrian regime position sat within range to harass the site with sporadic small arms fire for the entirety of the project, further complicating the project.[14]

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Construction at Pump Station #1 proved more difficult and required more flexibility than expected. Usable space for staging and maneuvering materiel and equipment was at a premium at the project's outset, and diminished hour by hour as pumps and newly fusion-welded pipe structures were assembled and emplaced. Constant positioning changes for the large crane and construction of the unwieldy welded pipe sections slowed the project beyond the initial planning estimate, thought to be conservative at the time. Pipe lengths expected through USACE-produced drawings were extremely variable due to the on-site field measurements and larger hydraulic jump. The engineer team had conducted hands-on training with special equipment (the pipe cutter and welder) prior to forward staging, but these spatial challenges, and effects of the wet, freezing conditions, were not adequately accounted for in rehearsals or imagery walkthroughs. The first mission to Pump Station #1 thus served a secondary purpose as a rehearsal for follow-on missions, each of which was demonstrably more efficient and effective based on the lessons learned in January.[15]

While management of the physical space on site proved more challenging than anticipated, rehearsals paid dividends in the user-level technicalities of the project. Every team member was proficient in the use of the pipe cutting and welding systems, as well as the commercial heavy equipment on hand for moving pipe sections and pumps. Coupled with the experience gained at on-site vendor training for the pumps, the diversity in skillsets of the USASOC team members and DCC engineers enabled quick adaptation to changes in conditions, site layout, and equipment/material performance. Despite delays due to the space management difficulties, the intake portion of the Station #1 system was constructed and operationally tested within seventy-two hours of arrival on the second visit. The output configuration proved more reticent; the pipes and joinery originally selected for output failed to perform under real-world conditions and were unable to handle the pressure and flow requirements of transporting water uphill to the canal output. The team was thus forced to plan and execute a second mission with more suitable output pipe to complete construction at Station #1.[16]

In the weeks following the first, incomplete mission, the team rapidly sourced true high-density polyethylene high-strength intake pipe for use in system outflow. A second mission to Station #1 and additional missions to Stations #2, #3, and #4 were planned and executed based on the lessons learned from the first. Station #1 work was primarily conducted by USASOC engineers with DCC staff receiving equipment familiarization and training. Station #2 work was conducted by both the USASOC engineers and the DCC staff together. Finally, after delivery of the equipment and supplies and a brief two-day mission, Station #3 was entirely constructed by the DCC staff without USASOC assistance. At each pumping station, the equipment was officially divested to the DCC upon completion of the partnered installation. By mid-spring, USASOC and DCC partners had completed construction along the length of the canal, successfully bypassing the devastated permanent infrastructure and supplying water along the length of the canal to Pump Station #4.

Local Project, Regional Outcomes

In May 2019, a DOD media account noted that "U.S. military civil engineers recently assisted the Deir-ez-Zor Civil Council Engineers through the installation and completion of a water pump station near Suwar, Syria … The project was a culmination of six months of planning, procurement, and three months of construction assistance. This water will support the residents of Suwar and the various Syrian Democratic Force outstations in support of ongoing back clearance operations to prevent the resurgence of Daesh."[17]

On 15 August of the same year, SDF and the DCC hosted a ribbon-cutting ceremony at Pump Station #1. By this time, the hasty bypass solution had been successfully adapted to the peculiarities of each site, installed, and was running the full length of the canal, restoring water access to "more than 70-thousand inhabitants in the Khaor River Valley."[18] Air Force Maj. Gen. Eric Hill, then commander of Special Operations Joint Task Force–Operation Inherent Resolve, noted with regard to the project that the "Coalition's partnership with the SDF and efforts through local military councils bring security to the region … essential to the enduring defeat of Daesh."[19]

Concurrent with the installation of bypasses at each station, the USASOC team worked with local engineers to build a bill of materials for the longer-term project of repairing the original infrastructure. The knowledge and firsthand experience of those engineers was vital to identifying and procuring suitable replacement parts for the aging and severely damaged system. In the intervening years, U.S. agencies and local governments took up the banner on the enduring large-scale water restoration project. Funded by the U.S. Department of State's Bureau of Near Eastern Affairs, the Facilitating Urban Recovery and Transition Plus project partnered with the Executive Council of Jazeera Region and the DCC to take on the broader system of water infrastructure.[20] Through their efforts, the lift stations along the canal, the channel, supplementary pipelines, and the electrical network were repaired or upgraded by the end of 2020, converting the temporary bypasses into standby redundancies in favor of a more sustainable and resilient primary system.[21]

Project Observations

The "by, with, and through" operational approach applied across multiple conflicts in Central Command was unique in Syria due to the nonavailability of a viable partner state. "The lack of host government support complicated logistical support" to chosen-partner forces, "putting a greater reliance on SOF trainers and advisors."[22] In the case of the Suwar Canal, the Syria-specific by, with, and through approach precluded handing complete responsibility of the project over to a U.S. partner. A similar infrastructure project in Iraq, for instance,

U.S. Army Special Operations Command team members receive hands-on training with pumping equipment at a vendor testing location in November 2018. (Photo by author)

could have been more suitable for Government of Iraq execution with U.S. planning-only support, whereas the coalition of chosen-partner forces in Syria were not appropriately organized to pivot midcampaign from tactical operations to major infrastructure. Nor did the partner force maintain organic engineering assets capable of such a mission. A unilateral U.S. military construction project, on the other hand, may produce the desired tactical and humanitarian end state but fail to build postconflict legitimacy for partner forces and local/regional governments in Deir-ez-Zor (to say nothing of its appropriateness amidst the troop drawdown taking place in 2019). Senior SOF leaders see the influence generated by SOF's long-term engagements as key to providing expanded options and preconflict awareness.[23] In this case study, the strength of relationships between various SOF elements and their local counterparts (such as those between civil affairs teams and the local military/civil councils) was key to finding a solution that balanced the military end state with reticence to take unilateral control of the project. Partnership with the local civil council enabled the USASOC team to provide interim capability through the partnered bypass repair while setting conditions for more protracted permanent repairs via planning and logistics aid. From the project's nascent stages, planning was contingent on the value of the original site assessment: a high quality, technically robust report made by a small team in a degraded semipermissive environment. Consistent with doctrine, the team's ability to rapidly identify and deploy to the scene of the problem and conduct valuable assessment with partner SOF and local engineers undergirded the entire project. Success in planning also relied on bringing together various

Dier-ez-Zor Civil Council engineers and U.S. Army Special Operations Command team members finish installation of discharge pipes February 2019 at Pumping Station #1 on the Euphrates River in Syria. (Photo provided to author by project engineer)

Department of Defense stakeholders. The premium placed on relationship building and cross-enterprise collaboration by SOF organizations was essential to success. The Engineer Regiment lent its robust reach-back capability, and the broader engineer community provided critical planning support via USACE Portland's additional collaboration during the planning phase.

Unique SOF authorities for both procurement and partner force interoperability were essential to mission success and mission haste and were navigated effectively by a coordinated cell of logistics, procurement, and legal experts at USASOC. Execution of the project was joint (including engineers and logisticians from three services) and multinational, with the assistance of local engineers as technical advisors and a local national contractor for specialty equipment operation on site. The USASOC team, though small (five to six people), was nonetheless able to leverage organic language skills, communications capabilities, and relationships with sister units and local partners to multiply their effectiveness. "Diversity in our SOF formations provides an asymmetric advantage," and, in the case of the Suwar project, proved the value of unique skillsets in providing "innovative solutions to key operational problems."[24]

Setting Conditions for Future Success

The Suwar Canal project encountered hiccups in planning and execution, and fortunate timing played a role in its eventual success. However, there are aspects of the operation that speak to the SOF truth of "humans before hardware" and that suggest the usefulness of nonstandard infrastructure in achieving various military end states.

At an individual level, replicating the success of the Suwar project calls for recruiting, training, and retaining personnel with exceptional diversity in skillsets. The handful of SOF personnel on site brought to bear

The newly refilled Suwar Canal flows northeastward from the Euphrates River in spring of 2019. (Photo from the Special Operations Joint Task Force–Operation Inherent Resolve [SOJTF-OIR] Facebook page)

language skills, significant engineering credentials, and experience with the various materials, machines, and trades that made up the construction site. The global built environment is expanding, and exposure to the full range of infrastructure that underlies contemporary societies will be of increasing importance, both for bespoke SOF missions, and for advising maneuver commanders in more conventional combat operations.[25] Likewise, as SOF shifts its gaze to the broader competition spectrum, multifunctional teams with technical prowess and operational savvy will require recruiting from nontraditional populations, and integrating those skillsets from staff positions to agile assessment teams.[26] It is no revelation that nonmilitary activities can have military outcomes. The wars in Iraq and Afghanistan were replete with construction projects and construction assistance meant to improve regional stability or enhance credibility of local governments. Whether those efforts were effective has been examined by more qualified researchers; instead, the Suwar case study is presented as an example of using infrastructure to achieve acute effects, rapidly, when conventional forces or governmental partners cannot. Joint doctrine accounts for infrastructure as a planning factor in understanding the operating environment but falls short in providing language or guidance for integrating the ubiquitous built environment into other phases of operational planning.[27] Competing below the threshold of armed conflict, across multiple domains, will require a more sophisticated and creative view of the built environment in both conventional and special operations. The president of the Joint Special Operations University called for SOF to be transdomain problem-solvers, ready to take actions that "may be far removed from the point of effect … [to] indirectly affect behavioral and decisionmaking calculations."[28] Infrastructure may offer opportunities to convert physical action into positional advantage in other domains.

Our adversaries certainly recognize the potential of infrastructure across the competition spectrum. The People's Republic of China famously uses infrastructure as a means of exercising both tactical and strategic power through their Belt and Road Initiative, wherein construction may be a device of profit, a tool of coercion, or a venue for future positional advantage.[29] This approach to infrastructure as more than its component concrete and steel lends itself to planning for competition: physical infrastructure is one access point to the systems and networks that we wish to protect, or to target.[30] China's own operating environment is characterized and networked by deepwater ports, manmade islands, terrestrial-based space systems, and many more built components that amplify, or deny, power projection. The Belt and Road Initiative and Chinese military infrastructure are beyond the purview of this paper, but their complexity suggests that our own planners, regardless of doctrinal direction, should examine how infrastructure can be integrated across operations in unexpected ways—as an objective, as a vector for an effect, or as an effect itself. The Suwar Canal project is, at best, an elementary example of this idea. By matching a unique, limited capability (rapid assessment, agile procurement, construction assistance) against a problem tangential to direct combat, leaders were able to leverage infrastructure to change the battlefield in their favor. Future operations may entail less overt use of construction while relying all the same on infrastructure expertise to achieve tactical effects (sabotage, special mobility), information effects (credible infrastructure assessment), or humanitarian outcomes (expeditionary construction). Mastery of the built environment—the physical domain—will enable SOF leaders to achieve transdomain effects.

In his account of OIR, Michael Douglas, author of *Degrade and Destroy* and a *Wall Street Journal* national security correspondent, concludes, "The U.S. experience in Inherent Resolve also points to the need to formulate a better strategy for reducing harm to civilians. This means reducing civilian casualties as military operations proceed and also mitigating the long-term risk to innocents when their infrastructure is destroyed … The imperative is important not only for humanitarian reasons but also to avoid handing a propaganda victory to the enemy."[31] The Suwar Canal project was one of several instances in the counter-IS campaign where SOF engineers were directly responsible for identifying, assessing, and mitigating major infrastructure failures, in turn mitigating impacts to civilian populations and partner military forces alike. In competition and conflict, applying infrastructure expertise to nonstandard problems can produce outsized military and humanitarian effects. SOF leaders are uniquely positioned and equipped to identify these opportunities and use infrastructure as a vector for their desired tactical and operational outcomes. ■

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